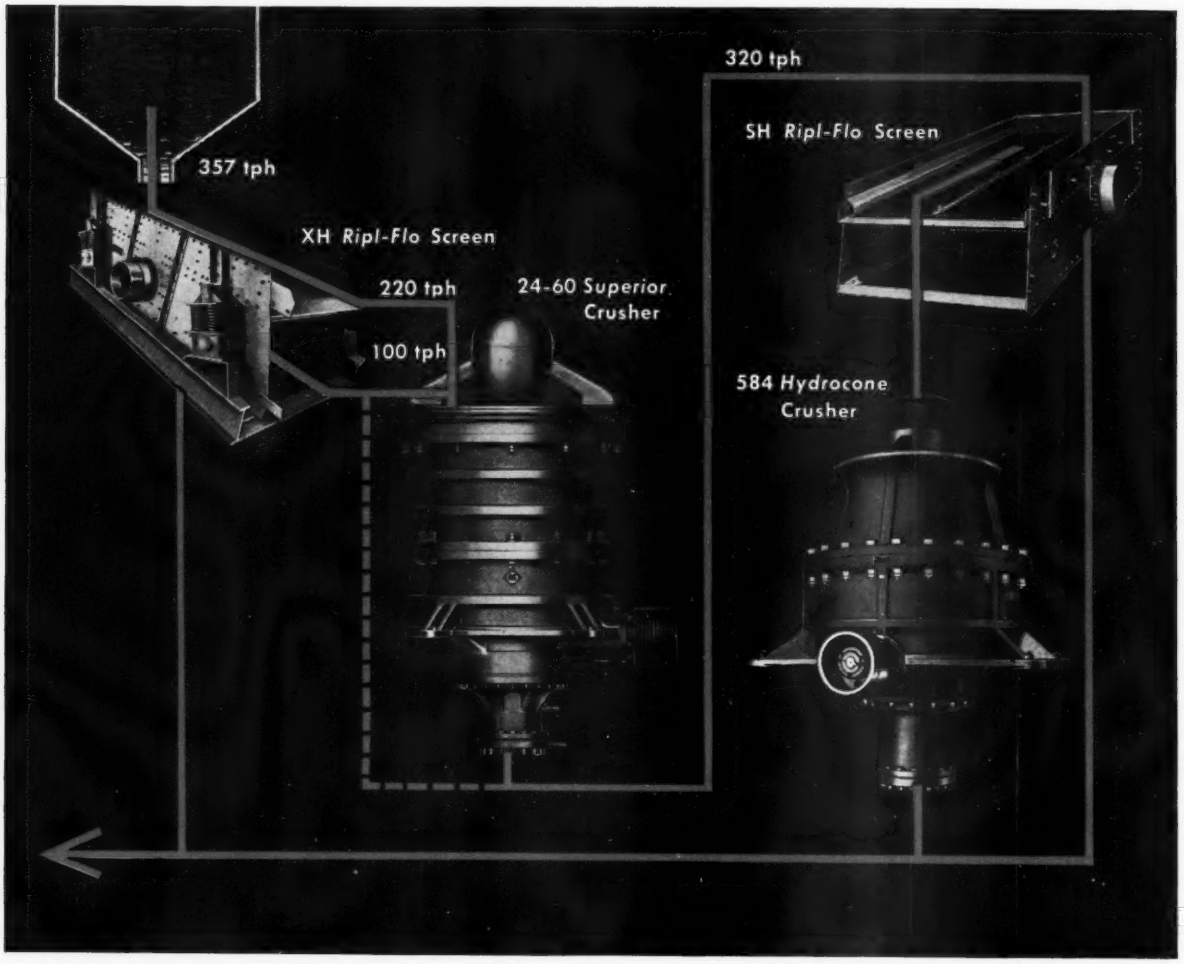
MINING CONGRESS JOURNAL

JUNE 1961

COAL SHOW REPORT

See page 25

ALLIS-CHALMERS



King-size crushing job—from 16" feed to ¾" product—with

two crushers instead of three

Two important efficiency factors were the key to a new installation in Southwest "copper country."

First of all, only Allis-Chalmers could furnish the right-sized crushers to do the job. A 24-60 *Superior* gyratory is the primary crusher for reducing raw 16" ore down to 2½". Final crushing, down to ¾", calls for a 584 fine chamber *Hydrocone* crusher. It's normally a job for three crushers — but these two do the job dependably . . . and both are equipped with time-saving *Hydroset* controls.

Secondly, A-C engineering service specializes in designing plant flows that bring out the best in equipment . . . designed for maximum efficiency, step by step, from bin to storage pile.

Ask your A-C representative about complete engineering service and the size range of A-C crushers. Or write **Allis-Chalmers,** *Industrial Equipment Division, Milwaukee 1, Wisconsin.* A-1335

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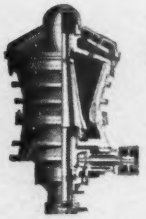

SUPERIOR gyratory crushers are built for rugged primary and secondary crushing loads. Capacities from 170 to 3500 tph. Twelve sizes.

HYDROCONE crushers, built to economize on secondary and tertiary stages, have capacities from 7 to 1050 tph. Twenty-one sizes.

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Opinions expressed by the authors within these pages are their own and do not necessarily represent those of the American Mining Congress.

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ON OUR COVER

Scenes at the highly successful Coal Show of the American Mining Congress — (top left) Raymond E. Salvati, AMC president, opens the Convention which drew over 12,600 mining men from all parts of the globe; (top right) the technical sessions provided a lot of "bread-and-butter" ideas; (lower left) Republic Steel was host for one of the special trips on Friday; (lower right) throngs of operators roamed the exhibit halls searching for ways and means to increase productivity. For the full story see page 25.

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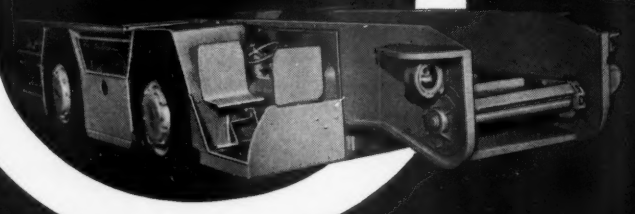

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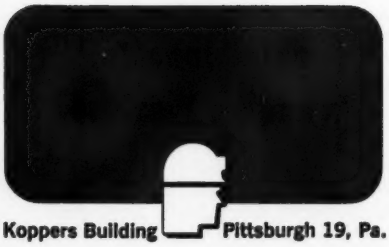

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featured IN THIS ISSUE—and the AUTHORS

A LOOK AT COAL'S FUTURE

What's ahead for coal? In order to determine its markets in 1975, as well as during the intervening years, the author takes a close look at the expected requirements of the various coal consuming industries, and predicts that coal consumption in the United States will reach 479 million tons by 1975. The export market should demand another 30 million tons, raising domestic production to over 500 million tons.

With a broad background in both business and government, C. J. Potter is especially well qualified to take "A Look at Coal's Future." He has been associated with Rochester & Pittsburgh Coal Co. since 1940—as president since 1947. His government experience includes service as a member of the Bituminous Coal Commission and as deputy administrator of the Solid Fuels Administration for War and Coal Mines Administration. A director of the American Mining Congress, he is widely recognized as a student of coal economics.

MAINTENANCE OF OPEN PIT EQUIPMENT

While equipment repair is the duty of the maintenance department, a good program extends responsibilities to everyone in a supervisory or management position. This is because maintenance is affected by decisions, policies and plans originating throughout a mining organization. Therefore it is vitally important that operating and staff personnel work closely with the maintenance group at all times to achieve a smooth-running operation where maintenance costs are at a minimum.

Robert Y. Jensen was assistant chief engineer of the M. A. Hanna Co. when he was killed in an airplane accident in the fall of 1960. He joined M. A. Hanna as a mechanical engineer in 1951. For the previous four years, he was a sales engineer for Ingersoll-Rand Co. in the northern Minnesota mining districts. He obtained his mining engineering education at Iowa State College and the University of Minnesota.

APPLICATION OF DIESEL UNITS UNDERGROUND

Tennessee Coal & Iron Division of U. S. Steel Corp. purchased three diesel-electric shuttle cars for use in its underground limestone mine in 1951. This two-wheel steer, two-wheel drive car represented a major step in the development of underground rubber-tired vehicles. All the limitations and problems associated with a cable reel were eliminated, including restricted length of run and route of travel. Today TCI has three diesel-electric cars and 13 straight diesels in operation in its ore and limestone mines. In addition, the company purchased 12 diesel front-end loaders, making the mines diesel equipped throughout all operating sections. Greater mobility, efficiency and safety have been the result of this move to dieselization.

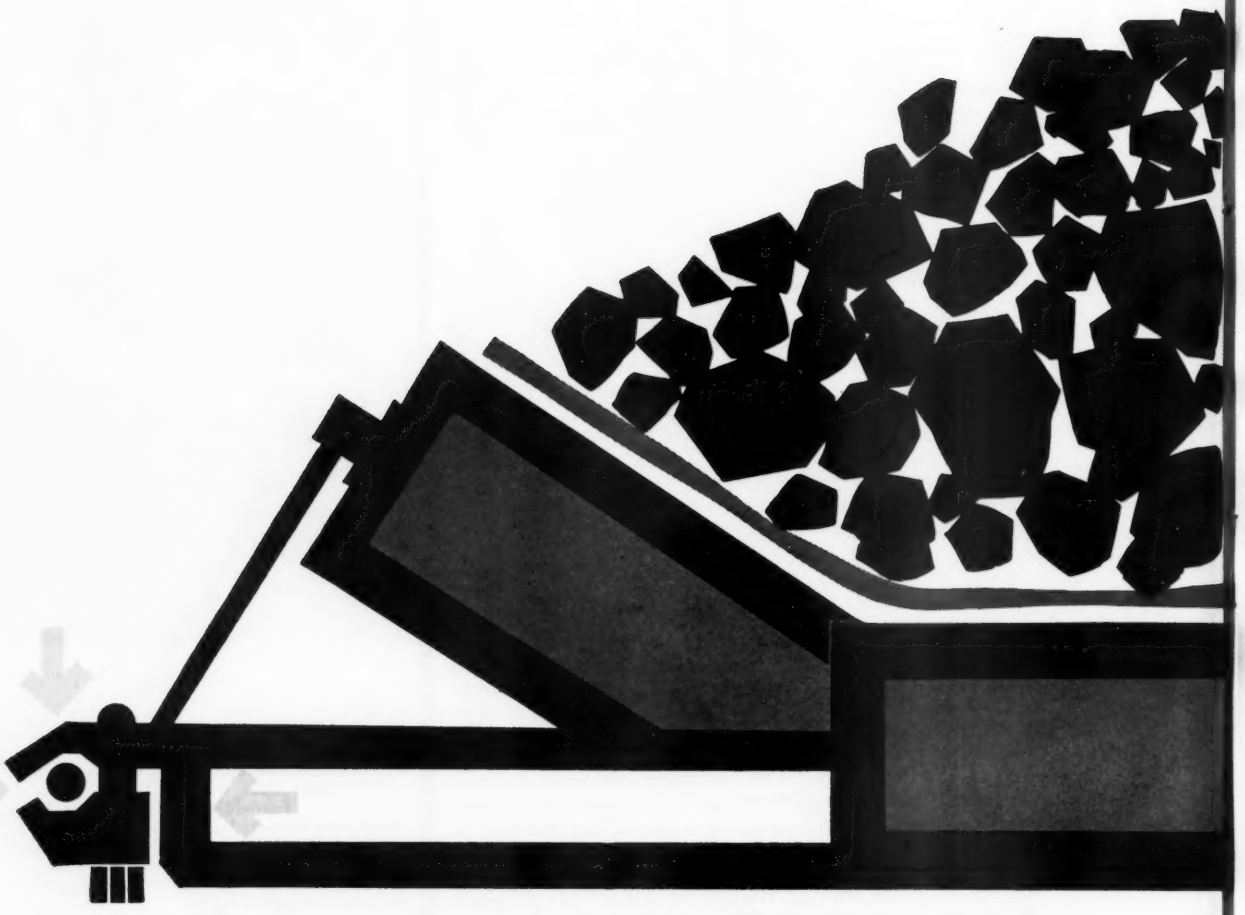
The entire Mining and Engineering Staff of Tennessee Coal & Iron Division, U. S. Steel Corp., Fairfield, Ala., had a hand in preparing the article on the "Application of Diesel Units Underground." An aggregation of considerable experience on the subject, the report bears careful study by all underground mining men.

APPLICATION AND PERFORMANCE OF WHEEL EXCAVATORS

There are two types of wheel excavators of interest to the mining industry. One is the large type developed primarily for the brown coal fields in Germany, while the other type was developed mostly in the coal strip mines of Fulton County, Ill. While both machines are called wheel excavators, they differ considerably in mechanical construction as well as in their application.

(CONTINUED ON PAGE 5)

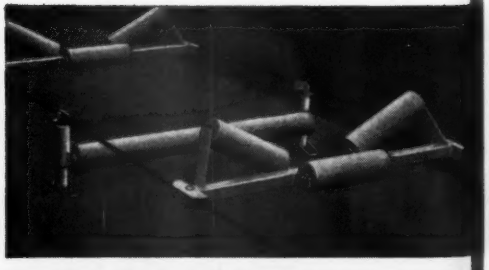
Henry Rumfelt's early experience was in plant, planning, and/or operation phases of heavy construction work, including various types of earthmoving, tunneling and quarrying. Since 1948 he has been associated with Bucyrus-Erie Co.



WHO ORIGINATED THIS BETTER BELT CONVEYOR?

LONG-AIRDOX did— just as they have pioneered so many other major advancements in coal mining equipment and methods.

This LONG-AIRDOX development, the "Lo-Rope" belt conveyor,* differs from old fashioned designs in that *the idlers mount on top of the rope side frames and are self-aligning.* Some of the proved advantages of this construction are: belts stay centered as belt motion tips the idlers in direction of travel; conveyor stays aligned—rocker support stands can't walk out of position: fixed deep troughing angle centers load better and increases belt capacity; ropes are completely out of the way, making it safer to handle men and supplies; and belts last longer because they can't be cut by hanger stands.



For more information detailing how you can move more coal more profitably with "Lo-Rope" belt conveyors, write the Long-Airdox Company, Division of Marmon-Herrington Company, Inc., Oak Hill, W.Va.

*U.S. Pat. No. 2,896,774

LONG-AIRDOX

(CONTINUED FROM PAGE 3) **IN THIS ISSUE—and the AUTHORS**

NEW DRIFTING METHOD AT BRITANNIA MINE

When the Britannia mine was reopened in 1959 after a ten-month shutdown, a major exploration project was undertaken that included driving a 5000-ft long, 8 by 8½-ft drift into the Britannia shear zone. Footage advance was targeted at 500 ft per month using three-man crews around the clock five and six days a week. With strictly conventional methods and such a small crew, the goal seemed almost too ambitious. Two major equipment items—a train adapted for scraper loading and a specially designed drill jumbo—made it possible to advance at the targeted rate.

FUTURE OF CONVENTIONAL MINING

Management must decide between conventional mining equipment and continuous miners when they propose to re-equip an old mine or open a new one. Conventional equipment offers maximum flexibility and a generally unrealized production potential. Where the flexibility is needed, and the production potential can be realized, conventional equipment is certainly the answer. Island Creek recently re-equipped two of its mines with conventional equipment and tonnage records are still being broken as the crews become more proficient.

PLASTICS IN METALLURGY FOR RESISTANCE TO CORROSION AND ABRASION

Modern plastics make it possible to use hydrometallurgical processes that were impractical a few years ago because of the lack of suitable materials of construction. Criteria for judging and predicting the behavior of plastics in particular environments are discussed, and some useful guides on selecting plastics for mineral processing applications are given. Examples of plastics used under unusually severe conditions of corrosion and abrasion at Kerr-McGee's Shiprock uranium processing mill are described.

FUNDAMENTALS OF MINE DUST CONTROL

A leading authority on mine air conditioning and ventilation discusses an effective mine-wide dust control program. To achieve this, it is necessary to meet all the objectives of total air conditioning where quality, quantity and temperature—humidity of the air are under simultaneous control. The nature of dust hazards, behavior of airborne dusts and principles of dust control are covered. General control measures such as ventilation, water infusion, exhaust systems, chemical binders, and dust collection are thoroughly described.

AUTHORS

Donald W. Pringle and H. R. Shuttleworth are manager and mine superintendent, respectively, of the Britannia mine, Howe Sound Co. Both joined the company in 1959 when the

D. W. Pringle

H. R. Shuttleworth

Britannia division reopened. Pringle was previously manager of the Western Nickel Corp. mine in British Columbia. Shuttleworth had earlier been mine manager at Cowichan Copper Co.

Jack N. Matheson, Jr., has been associated with Island Creek Coal Co. since February 1950. Starting as a trainee, he rose through the ranks—serving as section inspector, division industrial engineer, section foreman, assistant mine foreman and assistant superintendent—to his present job as chief methods engineer.

Mayer B. Goren joined Kerr-McGee Oil Industries in 1951 as senior organic chemist and is now chief research chemist at the company's Minerals Research Laboratory, Golden, Colo. For the two years prior to joining Kerr-McGee, he was assistant professor of organic chemistry at Northwestern University. His chief research interests are in ion exchange, polyelectrolyte flocculants and vanadium hydrometallurgy.

Howard L. Hartman has been professor and head of the Department of Mining at Pennsylvania State University for four years. Previous to 1957, he held faculty positions at Colorado School of Mines and the University of Minnesota. From 1947 to 1950 he was employed as an engineer with Phelps Dodge Corp. and as Arizona State Mine Dust Engineer.

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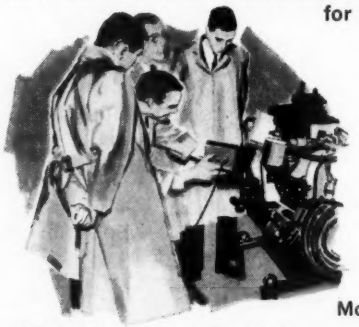

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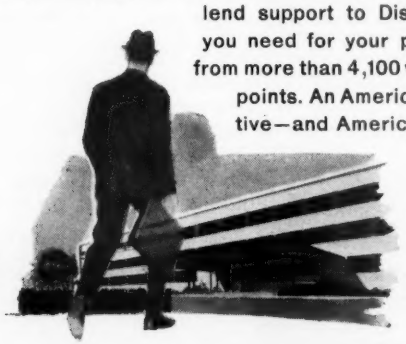

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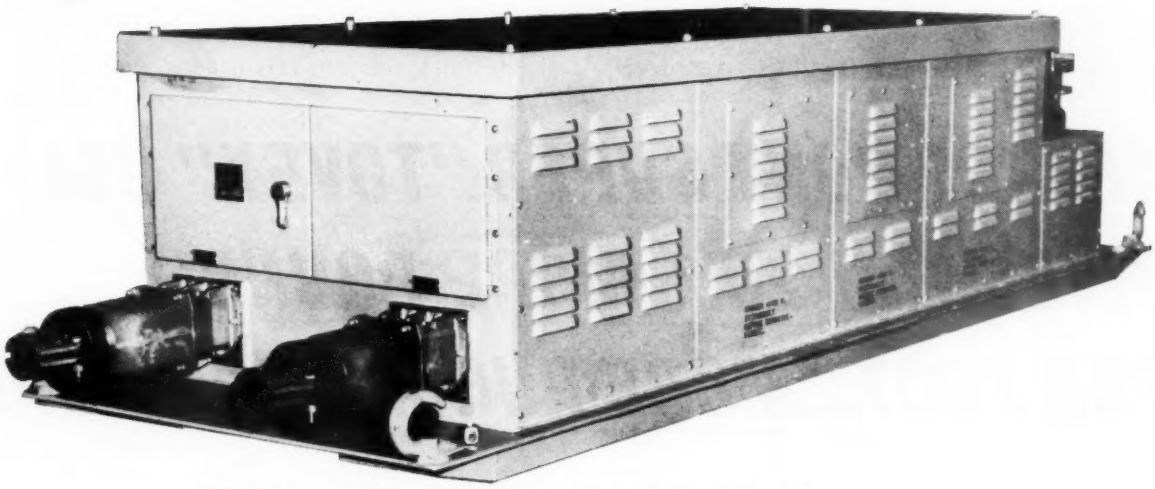
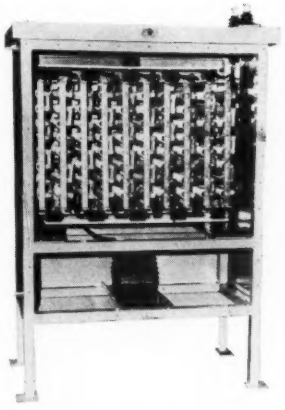
ENSIGN ELECTRICAL EQUIPMENT
FOR A.C. MINING

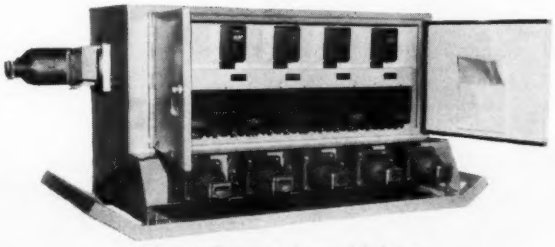


300 KVA Ventilated Underground Power Transformer

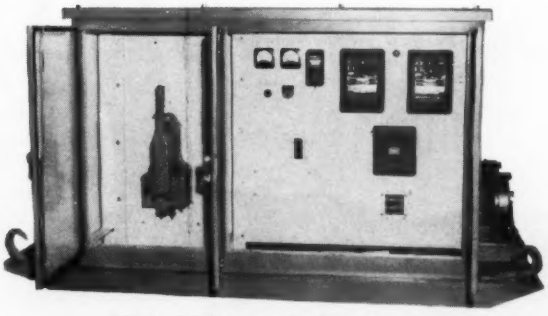


Neutral
Grounding
Resistor

Disconnecting Junction Box with
High Voltage Plugs and Kirk Interlock



Multi-Circuit Low Voltage
Underground Distribution Box



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2. Special shielding—a combination of copper cross-braided with cotton—eliminates chafing (and makes splicing faster and easier too).
3. Insulation is a special high-grade Butyl that withstands ozone, heat, and moisture.

Check all the features of this job-proved new shovel cable—they add up to extra cable life, less downtime, and dollar savings. Contact Department EFL-1-MCJ, Anaconda Wire and Cable Company, 25 Broadway, New York 4, N. Y.

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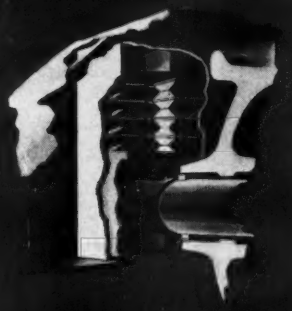
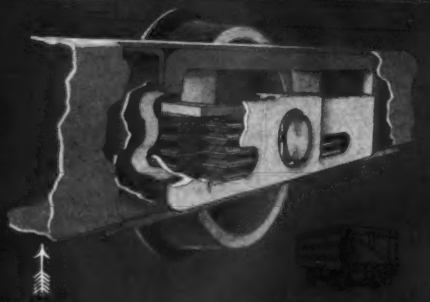
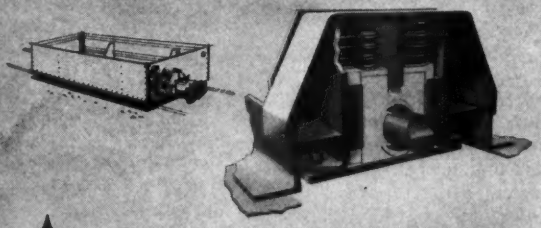


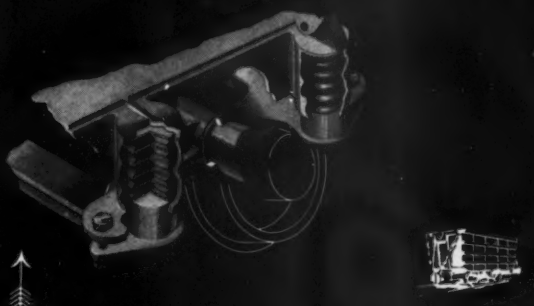
① National MI-245 rubber units, for 4-wheel rotary dump car, minimize vertical oscillation of cars through high absorption characteristics.



② Twin National MI-235 units used on each side of the axle center line and outboard of the wheels.

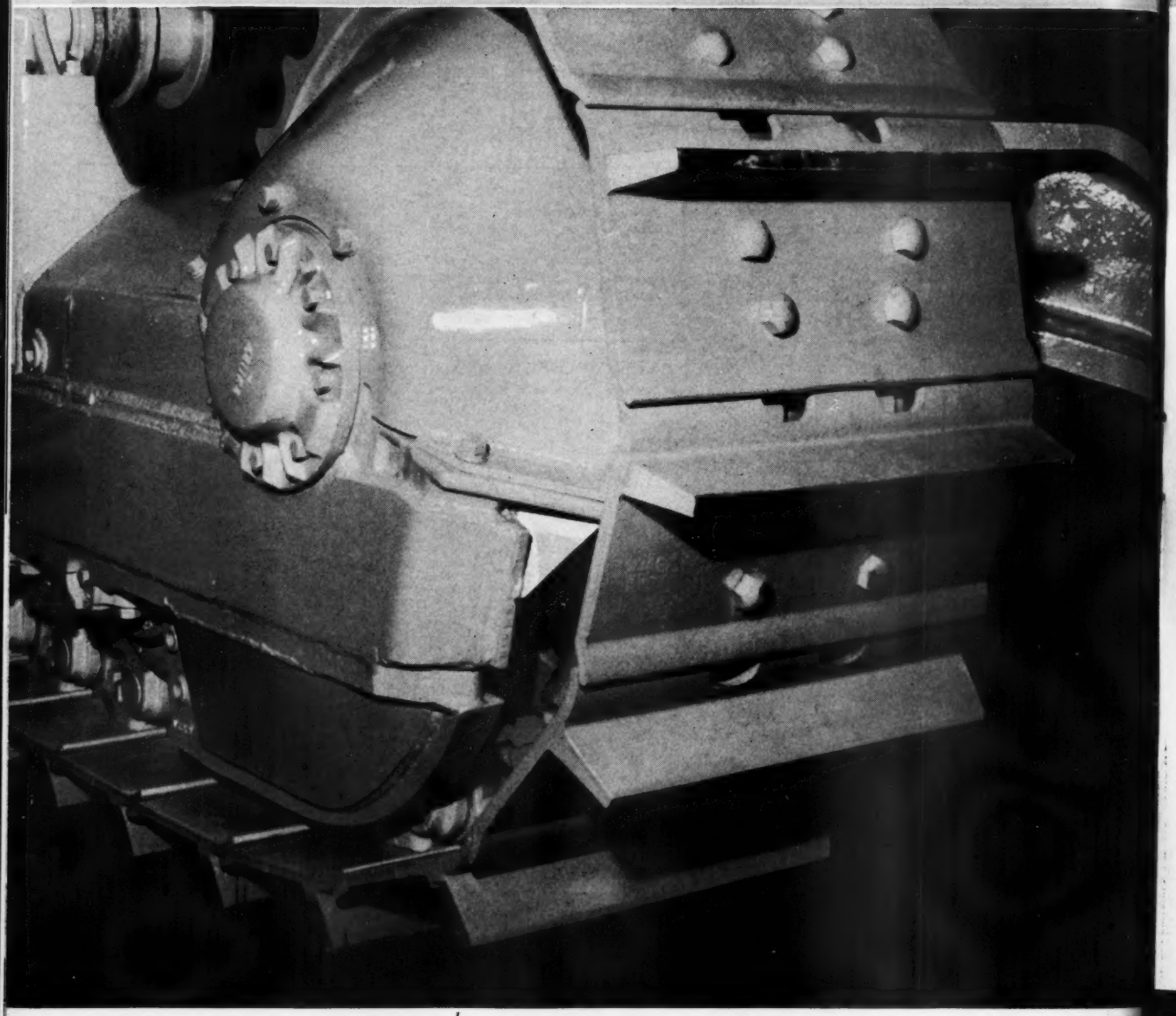


③ Twin National MI-240 units used on each side and over the axle inboard of the wheels.



④ Twin National MI-240 units, used in narrow body cars, are located in line with wheels to eliminate side overhang.

385 HP! FROM CATERPILLAR THE NEW D9G



MASSIVE HEAVY-DUTY UNDERCARRIAGE Immense strength and rigidity of undercarriage is one good solid reason why the D9G is more than equal to the roughest ripping job. Box section frame is wider and deeper than previous models. Hydraulic track adjusters are standard. Lifetime lubricated rollers with special alloy deep hardened rims assure long life . . . and they require no servicing until time to rebuild.

HIGH-PRODUCTION DOZER, PUSHER, RIPPER

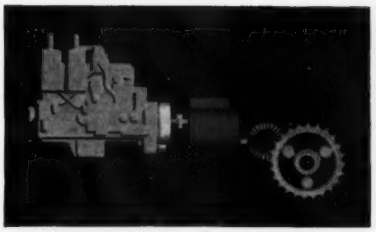
For high-volume dozing, pushloading or ripping, the new D9G has what it takes . . . at minimum cost per yard!

The engine in the new D9G delivers 385 flywheel horsepower. That's *100 more horsepower* than the first D9 introduced five years ago!

Weight is 64,800 pounds—14% more than the first D9!

Torque divider power shift transmission . . . massive heavy-duty undercarriage . . . and power train with built-in ruggedness for long life.

What else is new? Matching the D9G is a full line of attachments—all designed to help this new tractor really put out on the toughest big jobs.



CAT D353 ENGINE AND MATCHED POWER TRAIN This engine, rated 385 HP (flywheel) at 1330 RPM, has been proven—and proven again—over thousands of hours on the roughest jobs. Its 6.25″ x 8″ six-cylinder design now incorporates *controlled turbocharging* and aftercooling (found only in the D9G among crawler tractors), assures more efficient use of fuel, increases maximum torque and provides fast engine response over a wide range of operation. Shroud-mounted fan reduces air recirculation; torque limiting clutch saves on fan horsepower. Plus: exclusive Caterpillar fuel injection system, twin dry-type air cleaners, oil-jet-cooled pistons, "Hi-Electro" hardened cylinder liners and crankshaft journals.

The new power train includes three major advances: *new oil-cooled steering clutches and brakes, new planetary final drives*, and a time and cost saving *common lube system*. The new spring-engaged, hydraulically-released steering clutches need no adjustments . . . have a proven longer service life. New, planetary final drives increase gear reduction ratios from 8.8:1 to 18:1, reducing torque load on all power train components. A common system cools and lubricates torque divider, transmission, bevel gear, steering clutches and brakes. This means one service point . . . one type of oil. The entire power train of the big new D9G has unitized construction for fast, individual removal of components.

PROVEN TORQUE DIVIDER POWER SHIFT This exclusive Caterpillar design feature—standard equipment on the D9G—combines the efficiency and snap of direct drive with the load-matching and anti-stall characteristics of torque converter. A single lever gives the operator finger-tip control of his machine. It adds up to fast cycle times and greater efficiency. You get more out of the machine *all day*.

A FULL LINE OF HIGH-PRODUCTION ATTACHMENTS New cable controls with larger clutch, brake and drum capacities—hydraulically boosted . . . new hydraulic controls in nine arrangements . . . special cushioned pushing equipment . . . angle, straight and U dozers, cable or hydraulic . . . rippers . . . scrapers . . . and others.

To prove the D9G's productive capabilities on your job, talk to your Caterpillar Dealer.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

CATERPILLAR

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NEW D9G—BIG, POWERFUL, PRODUCTIVE

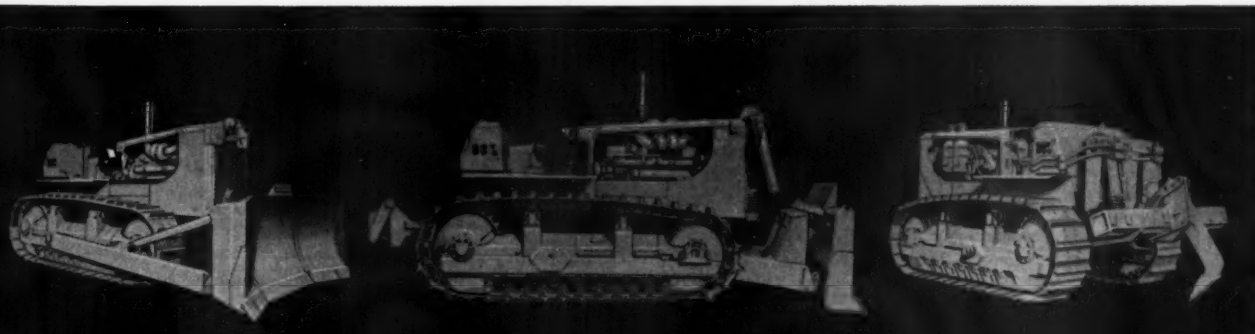


Photo courtesy of The Jeffrey Mfg. Co.

COMPARE R/M "COALMOVER"

With Any Other Conveyor Belt on the Market

- **Light Weight for Easy Handling & Re-spooling**
- **Holds *All* Underground Types of Fasteners *Longer***
- **Solid Edge Construction Eliminates Fray & Fan Out**
- **Engineered to Haul *Either* Side—Top or Bottom**
- ***Higher* Pulley Grip at *Lower* Tension—No Slip**
- **High Coefficient of Friction—No Coal Slippage as with Plastic**
- **Will Not Stiffen at Low Temperature—*Not* Thermoplastic**

In addition, this *entirely new* conveyor belt designed and engineered for the coal industry gives you *exclusive* R/M flexibility over reverse bend and snub pulleys.

It trains naturally, troughs easily to haul full loads in low headroom—with maximum resistance to rips, gouging, abrasion and impact! "Coalmover" requires minimum take-up adjustment—and like all R/M underground conveyor belts it's fire resistant throughout. *Designated "Fire Resistant, U.S.B.M. No. 28-10."*

Let an R/M distributor show you how to meet the new standard for performance with "Coalmover" Conveyor Belt.

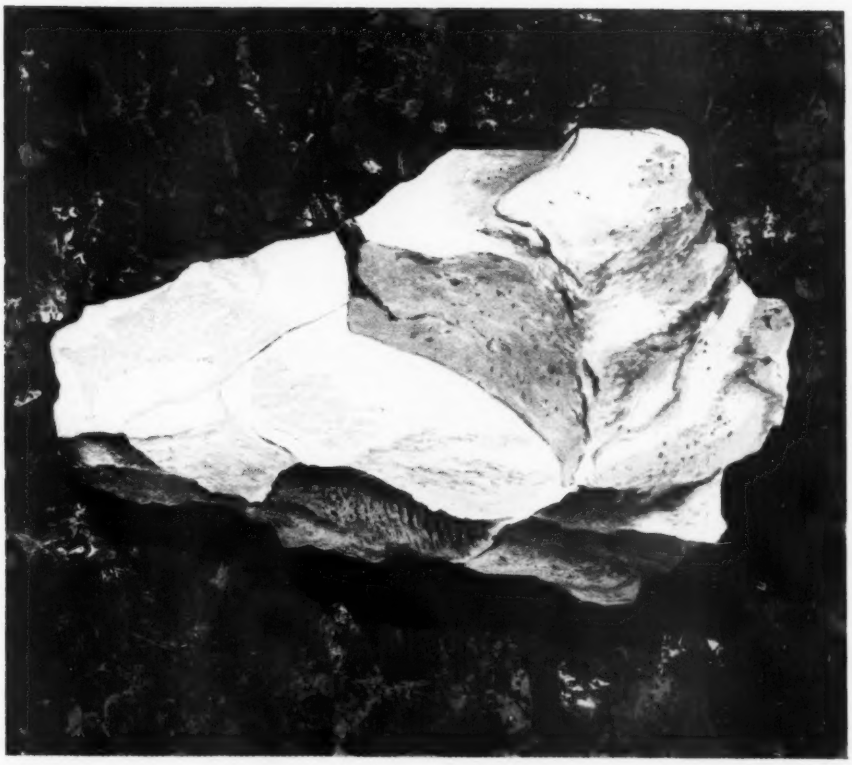
"COALMOVER" HAULS MORE...LASTS LONGER...COSTS LESS

RM105

RAYBESTOS-MANHATTAN, INC.

MANHATTAN RUBBER DIVISION • PASSAIC, N. J.

ENGINEERED RUBBER PRODUCTS

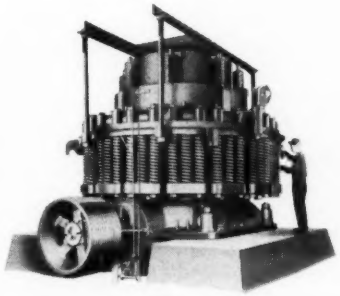


Dolomite

the "building blocks" of progress

When Nature adds magnesium to limestone, the result is *dolomite.* In the form of crushed aggregate, it is used for road building, in concrete dams and other engineered construction projects. As crystalline dolomite marble, it is used as ornamental building stone. And because of its magnesia content, it is widely used in making refractories for open-hearth furnaces and Bessemer converters. Found in massive beds throughout the world, dolomitic limestones are truly the building blocks of progress.

In processing this rock-mineral, Symons Cone Crushers have again maintained their leadership in high capacity, low-cost production of finely crushed product. *For in dolomite as in all important rock and ore crushing operations around the world,* Symons Cone Crushers are first choice of leading producers.



SYMONS® CONE CRUSHERS
. . . The machines that revolutionized crushing practice . . . are built in a wide range of sizes, for capacities to over 1500 tons per hour. Write for descriptive literature.

SYMONS . . . a registered Nordberg trademark known throughout the world.

NORDBERG MFG. CO., Milwaukee 1, Wisconsin

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C-181

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SAN FRANCISCO • TAMPA • WASHINGTON • WICHITA, KAN. • TORONTO • VANCOUVER • JOHANNESBURG • LONDON • MEXICO, D. F.

WORLD'S BIGGEST PAYLOAD!

Haul 95 tons every cycle...with the **KW-DART** *95 EDT*

Today—off-highway hauling demands bigger payloads per cycle. KW-DART again meets the demand *first* with its 95 ton capacity End Dump Trailer.

Production goes *up fast*—and costs come *down*, with the 95 EDT on the job. Its KW-DART-designed transmission is performance-proved to be the finest in the field. Its rugged, universal-type hitch delivers maximum maneuverability with maximum stability.

The 95 EDT does the work of three medium-size haulers in one-third the time, at one-third the operating and maintenance costs. For information on how the 95 EDT can improve your operation . . . increase your production, write . . .

KW-DART TRUCK CO.

1301 North Manchester Trafficway
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KW-DART TRUCK CO.

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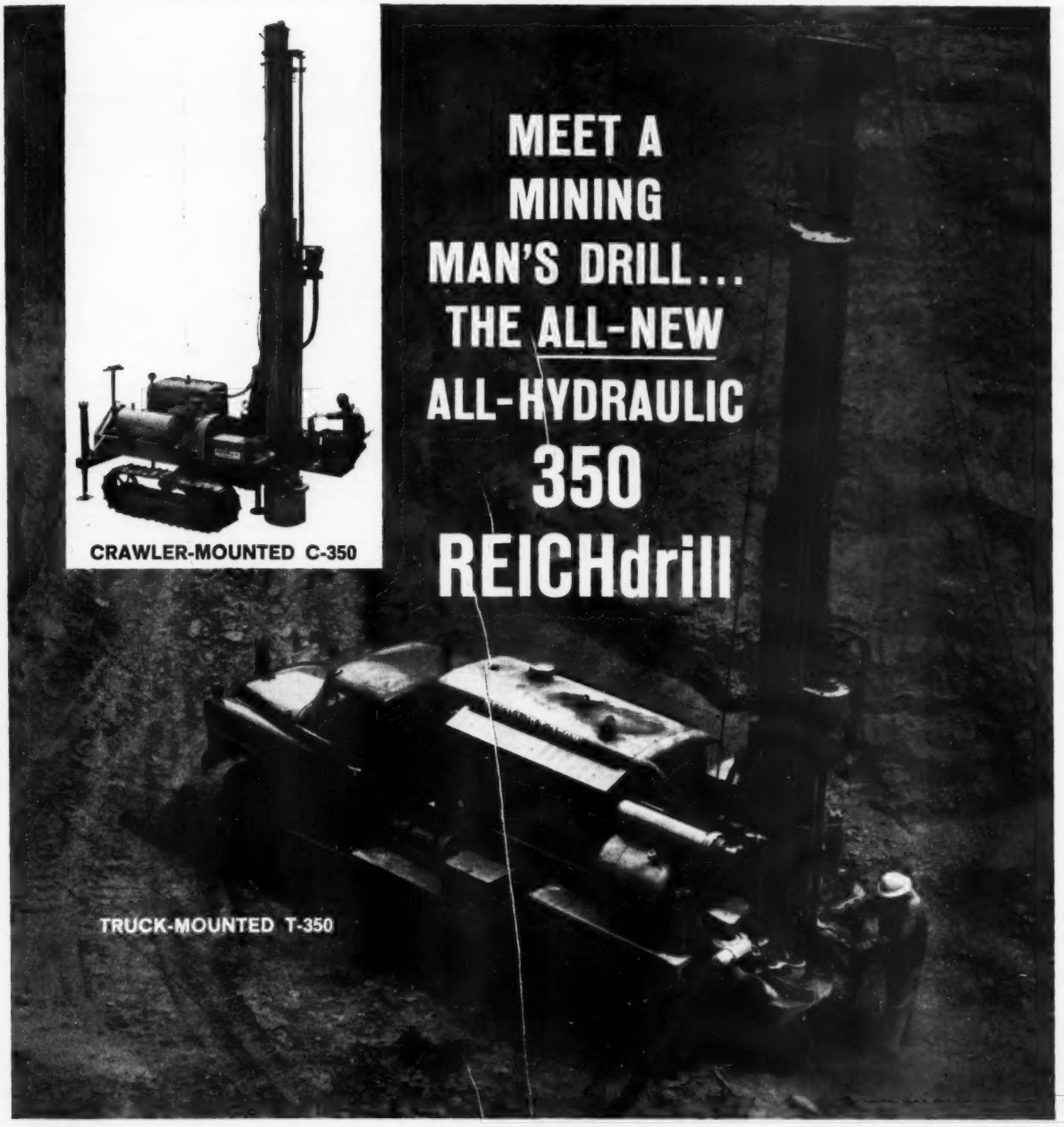


NOMINAL HOLE SIZE—1⅞" TO 5⅝" ● DOWN PRESSURE—10,000 LBS. ● ROTARY SPEED TO 540 RPM

Here's the ultimate in a mobile drilling rig for holes to 5⅝" ...the all-new 350 REICHdrill.

Job performance records under extreme drilling conditions have proved the cost-cutting advantages of its all-hydraulic features: Rotary Top-Drive; Precise Feed Pressure Control; Fast-acting Levelling Jacks.

The 350 moves in quickly...sets-up fast, breaks footage records on every shift. Handles 3-cone rotary bits, in-hole drills, diamond core bits, wire line tools, or drag bits.

C-350 Crawler-Mounted REICHdrill is unmatched for maneuverability and stability. Trams easily at almost 8 mph ...can climb a 25% grade...turn in its own length. Low center of gravity...wide tracks help it meet and beat any tough terrain.

T-350 W Truck-Mounted REICHdrill has all the time-saving, cost-cutting hydraulic features of the crawler-mounted unit. Offers complete mobility...saves schedule-killing time on moves between drilling sites.

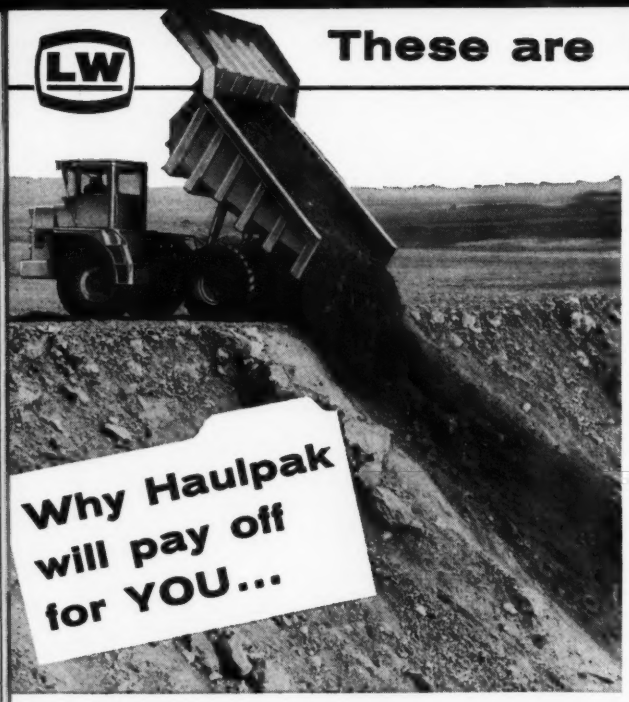
Ask for SP-5001-2

REICHdrill

FRANKLIN (VENANGO COUNTY), PENNA.

Division: CHICAGO PNEUMATIC TOOL CO.

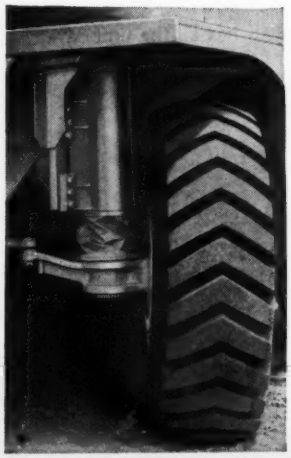
These are HAULPAK® advantages



A highway truck cannot become an off-road hauler just by increasing its "iron", horsepower, or capacity. That's why LW engineers "threw out the book" when designing Haulpak. They started from the ground up to design a *new* concept in off-road haulers. The result is a bigger, tougher, faster, safer machine... with bigger returns on your hauler investment.

1. "Power-Miser" radiator fan*, needs less than 10 hp. (Conventional fans need up to 35 hp!) Automatically disengages when not needed.
2. Cab, engine, and radiator, are fully mounted on rubber to isolate engine vibrations.
3. 15° windshield tilt reduces glare, keeps dirt and moisture from accumulating.
4. Automobile-sized steering wheel turns Haulpak full left to full right in only 4⅛ revolutions. In either direction, inside wheel can be cut full 45°, for non-stop turning circle in diameter as small as 44'6".
5. 52"-wide cab for greater operator comfort and efficiency. Offset to left for full visibility. Five adjustable ventilators. "Buddy" seat for trainee or time-keeper.
6. Double-reduction rear-end of drive train, proved on LW earthmovers around the world. Only 6 big gears, not 12 little gears as in conventional drives. And over 50% stronger than conventional drive trains!
7. 15% less hp is needed to turn gear train than on conventional trucks. Double-reduction drive assembly also permits bolt-circle wheel mounting, for far less trouble.
8. Differential is famed LW power-transfer unit, unequalled for simplicity, trouble-free operation, and effectiveness.
9. All tires are same size and interchangeable.
10. Frame fabricated of special alloy, high-tensile-strength steel. Modified box section construction, continuous welded with integral front bumper, center members, and rear cross section ... for maximum strength.
11. Exhaust-heated body is standard. Keeps body dry for easy discharge of wet, sticky materials. Eliminates exhaust stack, and muffles operation of truck for greater operator efficiency, safety.
12. Power-assist steering is standard equipment. All steering components are located high and protected by frame.
13. High front ground clearance ... 6 to 10 inches more than other haulers.
14. Aircraft-type multiple-disc brakes ... four times bigger than most haulers offer. *Three other brake systems*, including hydraulic retarder*.
15. Body is completely rubber-mounted. No wear bars or end plates needed.
16. High-pressure air storage in cross-frame, eliminates need for externally-mounted air storage tank.
17. Twin rams raise body to high angle in seconds! Inverted ram mounting avoids dirt falling into ram seals, permits shorter, simpler circuit.
18. Deep-well "V"-shape body carries up to 8 tons of material below floor line of conventional vehicles. Gives Haulpak lowest center of gravity, solid stability on turns and side-slope operations.
19. Fuel is stored in rear frame structure, with convenient center-fill. No need for big, clumsy tank, and not exposed to damage.
20. Straight, smooth body floor speeds ejection. No "kick up" at back, means unit stays steady, and on ground, when dumping.
21. Floor made of super-strength 100,000 PSI yield steel, as is every Haulpak surface in contact with the load!

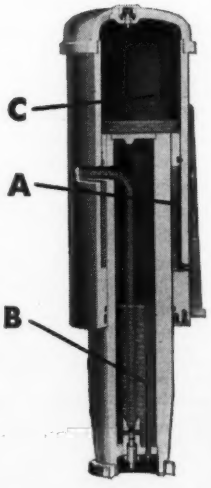
*Applies to the four largest size Haulpaks.



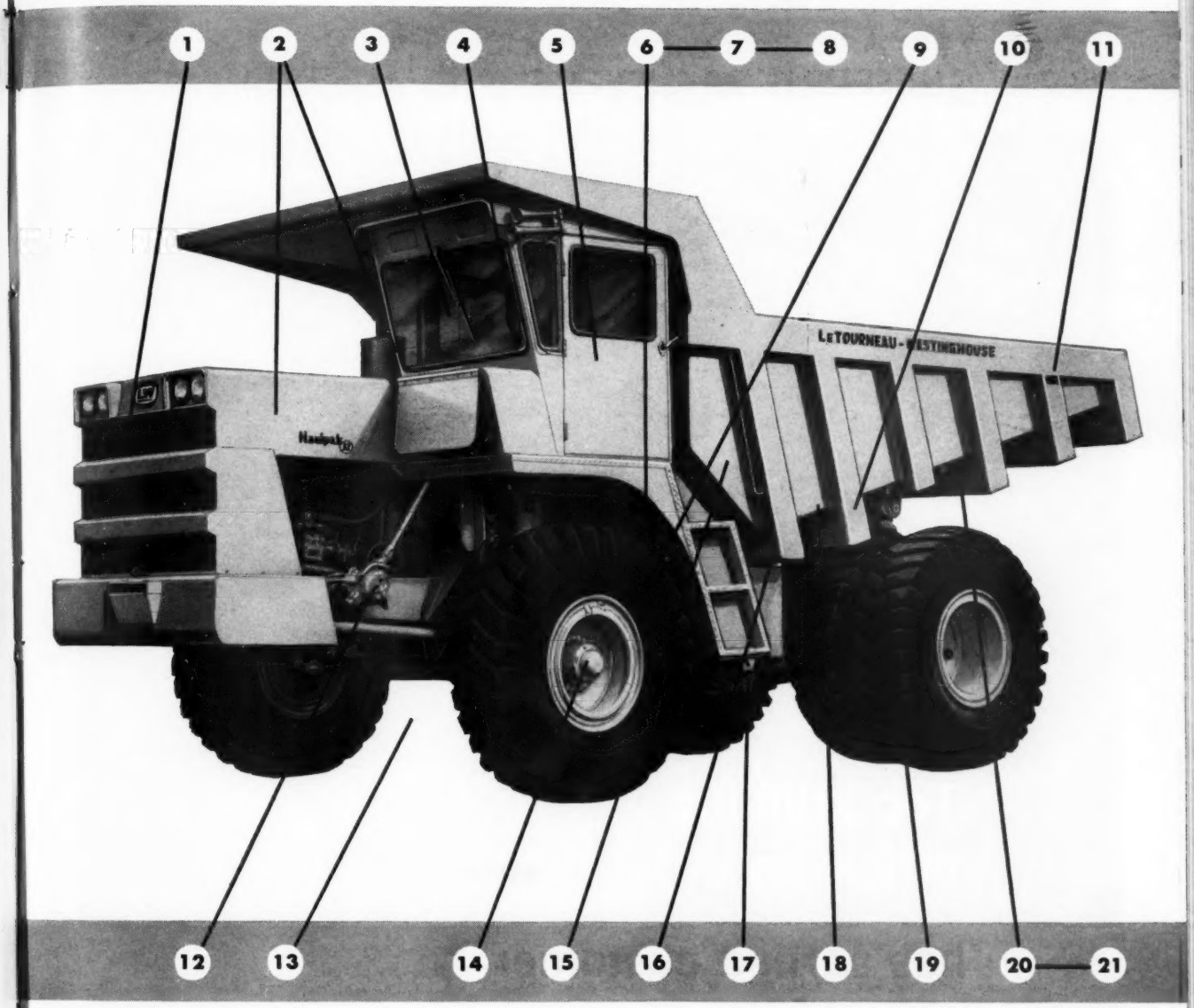
Perhaps the BIGGEST "difference": Revolutionary Hydrair® Suspension

Most *unusual* feature of Haulpak is Hydrair suspension. Each front wheel is mounted to a piston, which operates inside a frame-mounted cylinder. Surrounding the piston is a circular chamber of oil, (A) connected by tube to an oil reservoir (B) inside the piston. As the wheel rolls along surface irregularities, the up and down motion of the piston forces oil in and out of the piston reservoir. This, in turn, compresses and decompresses nitrogen gas contained in the space (C) above the oil reservoir, snubbing the overall movement of the piston and wheel, thus absorbing shocks and leveling the ride.

In addition to these "spring action" benefits, Hydrair eliminates the need for a front axle and related mountings... providing substantially higher ground clearance... and permitting an exceptionally short turn-radius.



that lower your costs . . . boost your output



HP-2422-G-2

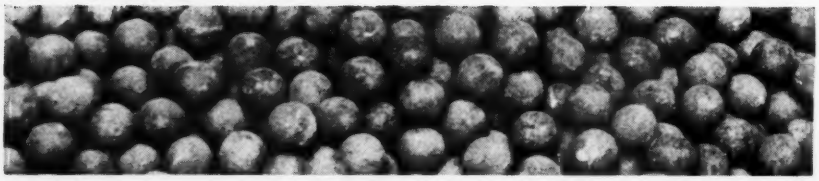
Choose HAULPAKS to match your production requirements

CAPACITY	60 Ton	42 Ton	32 Ton	27 Ton	22 Ton
HORSEPOWER	550	430	380	335	320
TOP SPEED (in MPH)	46.6	47.7	38.8	35.4	23.7
NET WEIGHT (in Lbs)	66,000	52,950	46,030	43,900	42,800

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

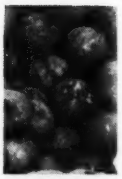
A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit



Strong
Tough
Economical
Efficient
Lasting

Steel



SHEFFIELD MOLY-COP Grinding Balls

has earned customer acceptance

Around the world, over a million tons of Sheffield Grinding Balls have given customers the top efficiency that comes from consistently uniform hardness, toughness and fine, dense grain structure right to the core. This uniform grinding efficiency (which also means uniform economy) is the result of Sheffield's constant quality control in alloying, forging and heat-treating — from furnace to finished ball. **Sheffield Plants: Houston, Kansas City, Tulsa.**

ARMCO Sheffield Division

NOW! Westfalia Coal Planer For Thick Or Thin Seams, Full Roof Control . . . True Continuous Mining!

The Latest Installation in West Virginia Is Operating Successfully After More Than Six Months' Continuous Production

The Westfalia Coal Planer, the only *truly* continuous miner, with new Westfalia self-advancing, hydraulic roof supports and the ability to operate in thick or thin seams, will cut costs while increasing production. The Westfalia system is fully adaptable to room and pillar mines.

You reduce costs because the durable Westfalia Coal Planer lowers maintenance and repair expenses, requires no other roof supports or bolting and is operated by a minimum crew. You eliminate cutting, drilling, explosives and all other loading equipment.

Production goes up because you extract all the coal across a working face which may extend up to 800 feet or more. Production is continuous since the Westfalia planer, conveyor and self-advancing roof supports press continually against the face. Burnt or sticking top coal is removed by the planer automatically.

The Westfalia System, first brought to this country through the cooperation of the U.S. Bureau of Mines and a coal producing company, has proved itself in several hundred installations in all important coal mining areas of the world.

Use coupon below, clipped to your letterhead, for further information. Consultation on engineering or equipment problems is readily available from our technical personnel at no obligation.

Mining Progress, Inc.

Sole Distributors for Westfalia Lünen

HIGHLAND MILLS, N.Y.

Mining Progress, Inc.
Highland Mills, N.Y.

I'd like to know more about the Westfalia System, the coal planer, conveyor and new hydraulic roof supports and how it can reduce costs while increasing production in thick or thin seams.

Name_____

Title_____

Company_____

Address_____

Better service accessibility alone makes the "Euc" C-6 your best tractor buy

In the Euclid C-6 crawler you get the advantages of job proved components and years-ahead engineering that keeps down-time and operating cost to the absolute minimum. You get unitized assembly of major components and service accessibility that is unsurpassed by any crawler . . . replacement labor costs are well below those for comparable tractors. For example, complete removal and replacement of a C-6 radiator takes less than one third of the time required for the same work on a competitive machine.

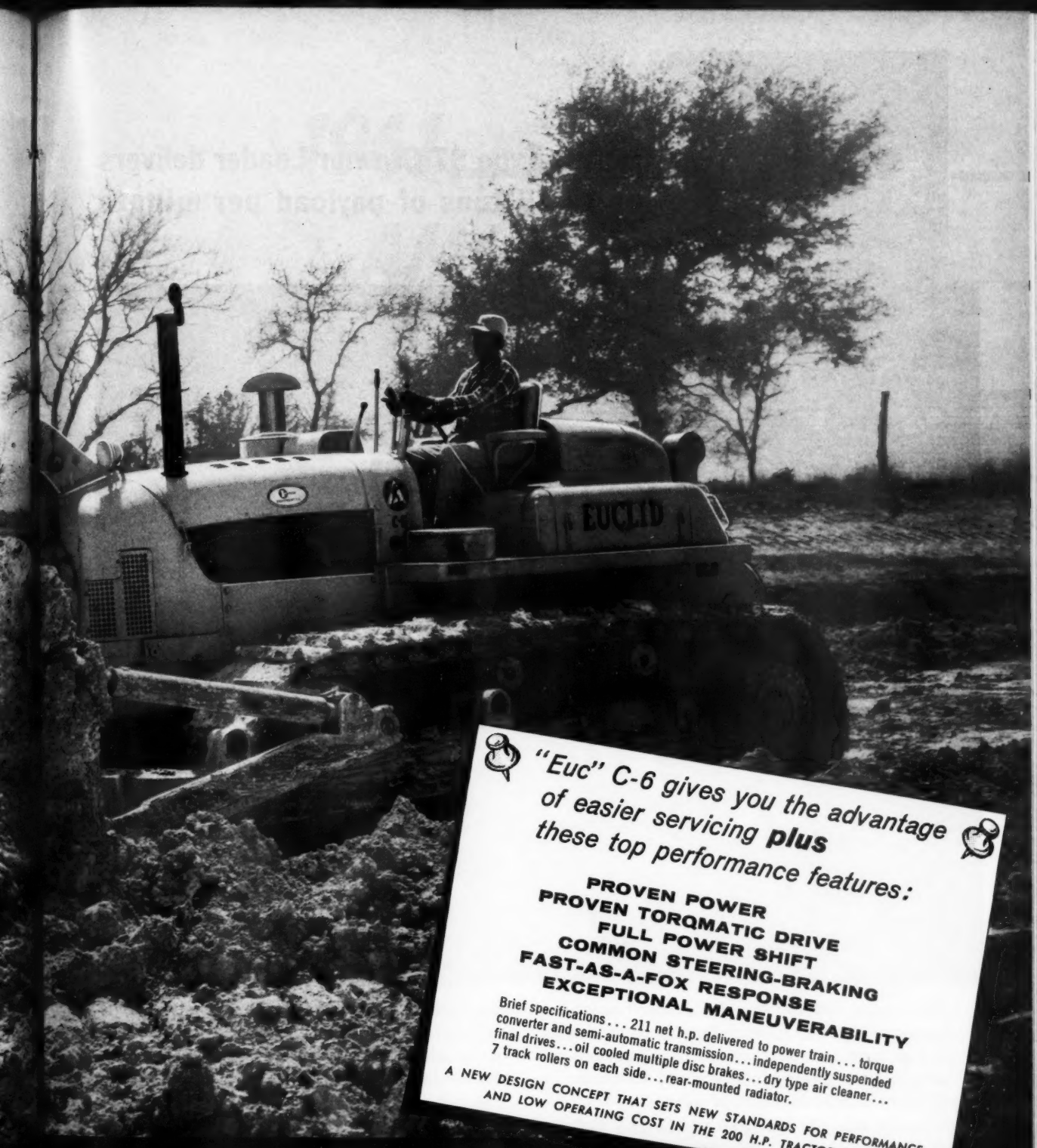
With easy accessibility for servicing and maintenance, the C-6 gives more work-time on the job . . . steps up production . . . helps beat the profit squeeze by cutting operating costs to a new low.

EUCLID Division of General Motors
Cleveland 17, Ohio

Plants at Cleveland and Hudson, Ohio and Lanarkshire, Scotland

Full-power shift . . . this Euclid C-6 crawler responds like nothing you've ever touched!

Get all the facts and figures on the C-6 . . . you'll find low operating cost plus proven reliable performance make it your best tractor investment.



"Euc" C-6 gives you the advantage of easier servicing ***plus*** *these top performance features:*

PROVEN POWER
PROVEN TORQMATIC DRIVE
FULL POWER SHIFT
COMMON STEERING-BRAKING
FAST-AS-A-FOX RESPONSE
EXCEPTIONAL MANEUVERABILITY

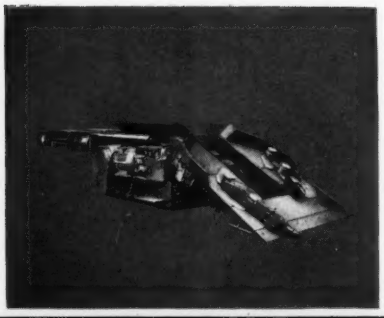
Brief specifications . . . 211 net h.p. delivered to power train . . . torque converter and semi-automatic transmission . . . independently suspended final drives . . . oil cooled multiple disc brakes . . . dry type air cleaner . . . 7 track rollers on each side . . . rear-mounted radiator.

A NEW DESIGN CONCEPT THAT SETS NEW STANDARDS FOR PERFORMANCE AND LOW OPERATING COST IN THE 200 H.P. TRACTOR CLASS

GM GENERAL MOTORS EUCLID

EUCLID

FOR MOVING EARTH, ROCK, COAL AND ORE



Jeffrey Type 97 Crawler Loader delivers up to 35 tons of payload per minute

The rugged Jeffrey Type 97 Crawler Loader has been developed to meet the problems of loading in high seam mines. It is a fast, easily maneuverable, high capacity loader rated to handle 21 TPM of coal or 35 TPM of salt.

Seven electric motors power the Jeffrey Crawler Loader; two drive the gathering arms, two are used for tramming, two provide a separate drive for the conveyor, and one is used to power the gear pump that supplies oil to elevate and swing the discharge conveyor and raise and lower the gathering head.

The Jeffrey Type 97 Crawler Loader is produced in two basic models. Type 97-A is designed specifically for loading coal. Type 97-B is designed to load salt, gypsum, or other similar materials. Standard heights of the Loaders are 43″ and 48″.

For detailed information about either model of the Jeffrey Type 97 Crawler Loader, write The Jeffrey Manufacturing Company, 958 North Fourth Street, Columbus 16, Ohio.

JEFFREY

If it's conveyed, processed or mined, it's a job for Jeffrey.

1961 AMC COAL SHOW

Mining men came to Cleveland in throngs to study latest developments in coal mining

"INTENSE interest" are the words that best describe the attitude of mining men attending the 1961 Coal Show of the American Mining Congress in Cleveland, Ohio, May 15–18. They made it clear that they were searching for ways to increase productivity as they studied closely the incomparable array of mining equipment on display and listened carefully to the many technical papers presented at the business sessions. The enthusiasm of the convention-goers was ample proof of their dedication to mining the Nation's coal at ever increasing rates of productivity —thus ensuring the future of this important source of energy.

Over 12,500 mining men came to Cleveland from all over the United States and from several foreign countries. In light of recent business conditions, the attendance was highly satisfactory. The number of operators registered, which was within 200 of the 1959 registration, was especially gratifying. There was general comment as to the high caliber of the mining men who attended and the serious attention which they devoted to the exhibits.

Interest in the technical sessions ran especially high, and from the moment AMC president Raymond E. Salvati called the opening session to order to the last address on Thursday afternoon the meeting rooms were well-filled. Capacity crowds heard leading mining men and Government leaders discuss national fuels policy, the Office of Coal Research, and coal's near-term future, as well as the latest advances in mining techniques, coal preparation, management problems and safety. A special session on "Cost Cutting Developments in Open Pit Mining," directed to the problems of metal mining men and industrial minerals producers, attracted particular attention. Credit is due the Program Committee, headed by F. Stillman Elfred, chairman of the board, Peabody Coal Co., for a fine job of lining up this year's speakers. All the addresses are reviewed in a special section beginning on page 73.

The 1961 Coal Show was actually a "re-

fresher" course in modern coal technology. The thousands of mining men who attended were able to study the latest developments in all types of equipment, and to hear and talk with key Government and industry leaders on ways and means to increase efficiency, promote safety, cut costs, and produce a better product.

Exhibitors Went All Out

The Exposition, sponsored by the Manufacturers Division under the chairmanship of D. E. Davidson, vice president, Link-Belt Co., occupied 134,000 sq ft of exhibit space, in which 249 companies showed the most varied and complete array of mining machinery ever assembled. From the deep interest shown in the equipment on display, it was evident that the detailed planning and effort put forth by the manufacturers paid off to the benefit of the whole mining industry.

Equipment was shown for every size and type of operation: continuous and conventional mining machines; coal preparation equipment; electrical supplies; explosives; huge coal haulers and earth-moving equipment, blasthole drills; augers, and all of the supplementary mining supplies and services. Most of the exhibits featured full-size machines and equipment; others used operating scale models, cutaways or action displays to emphasize certain operating features.

To even a casual viewer the advancing technology of the industry was apparent. Underground, the trend toward a-c power continued, and greater attention was given to improved machines for thin seam mining. As to strip mining, increased capacity and more power was stressed. Fine coal cleaning and automatic controls were the "passwords" with respect to coal preparation. Everywhere the accent was on increased productivity and safety.

The thousands of man-hours spent in visiting the Exhibition Hall will pay off time and again the months to come. The coal industry is out to strengthen its competitive position in the energy market, and this unparalleled opportunity to check and compare, investigate and analyze the latest machinery and equipment will unquestionably result in increased productivity in many ways.

Manufacturers Division Meeting

No technical sessions were held Monday afternoon or Wednesday morning so that full attention might be given to inspection of the machinery exhibits. The Manufacturers Division met Wednesday morning with David E. Davidson, chairman, presiding. Julian Conover, AMC executive vice president, reported on the activities of the organization during the past year and outlined plans for the Western Convention in Seattle, Wash., September 11–13. He preceded his remarks with a brief summary of the Manufacturers Division's activities since the Division was organized in 1922.

Jesse F. Core, chairman of the AMC Coal Division and vice president-operations-coal, U. S. Steel Corp., congratulated exhibitors on the fine display of mining machinery, noting the advances in their equipment that are apparent from year to year. He said the mining industry has relied heavily upon equipment manufacturers in the never-ending battle to increase efficiency and safety while reducing costs, but that the job is far from finished. The industry, he said, is looking for a productivity of 100 tons per man at the face, and at least 20 tons per man on the payroll. He pointed out that, although there are machines now available to mine at high rates of production, maintenance is still too costly and no feasible system has yet been devised to move coal away from the mining machines at peak production rates.

Core concluded his remarks by referring to the work of the AMC Coal Division, stating that, "these operating committees in the American Mining Congress do a better practical job of helping the operating end of the industry than any other organization in the coal industry. . . ."

The meeting was then addressed by Robert M. Hardy, Jr., chairman of the AMC Western Division and president, Sunshine Mining Co., who invited all present to attend the Metal Mining and Industrial Minerals Convention to be held in Seattle, September 11–13. He said that while there will be no machinery exhibition at Seattle, representatives of the mining equipment manufacturing industry have assumed important responsibilities in the organization of the meeting.

William E. Goodman, chairman of the board, Goodman Manufacturing Co., and chairman of the AMC Committee on Cooperation with Government Agencies, discussed the work of that committee during the past year, in organizing a Foreign Trade Export Conference between mining manufacturers interested in the export market and the Department of Commerce. At the present time the committee is studying an oppor-

tunity of working with the Bureau of Census to gather statistics on shipments of various mining machines. He said that any group of manufacturers, all producing one product, wishing to have statistics collected on annual shipments can get the Bureau of Census to do so.

Members elected or re-elected to the Division's Board of Governors are: P. F. Holstein, Westinghouse Electric Corp.; W. C. Clayton, KW-Dart Truck Co.; M. V. Cornell, Marion Power Shovel Co.; Charles B. Elledge, General Electric Co.; Jack H. How, Western Machinery Co.; Gordon MacVean, National Mine Service Co.; William C. McCulloch, Roberts & Shaefer Co.; William M. Wallace, Allis-Chalmers Manufacturing Co., and W. L. Wearly, Joy Manufacturing Co.

Retiring members are: Henry Barnhart, Baldwin-Lima-Hamilton Corp.; R. W. English, Victaulic Company of America; K. L. Fitts, Mack Trucks, Inc.; George Saar, Allis-Chalmers Manufacturing Co., and C. E. Hammond, Westinghouse Electric Corp.

At the Board of Governors meeting, which immediately followed, these officers were elected for calendar 1962: Austin Goodyear, Hewitt-Robins, Inc., Chairman; J. H. Sanford, Ohio Brass Co., First Vice Chairman; Edward T. McNally, Second Vice Chairman, and M. V. Cornell, Marion Power Shovel Co., Third Vice Chairman.

Land and Water Use

A joint meeting of the Land and Water Use Committees of the American Mining Congress and the National Coal Association was held Wednesday under the chairmanship of R. L. Ireland.

A review of pending and prospective legislation in the field of land use, water and air pollution was presented by AMC Executive Vice President Julian Conover. R. L. Ireland reported on the activities of the Air Pollution Advisory Council to the Department of Health, Education and Welfare stating that the group had considered the role of the Federal Government in air pollution abatement and various suggestions as to Federal-State relations in this field.

Reports were made as to land use, water and air pollution matters in the various States by committee members and discussions were had as to field trips for the technical members of the Land and Water Use Committees. Field trips to the West in June and to Florida phosphate operations later this year were considered and are to be arranged by Larry Cook, chairman of the AMC Land and Water Use Technical Committee.

Fun and Relaxation

While attention was focused on the machinery exhibits and the technical sessions, the lighter side was not neglected. On Wednesday night the Coal Miners Party was held in three sections, at the Pick-Carter, Statler Hilton, and Sheraton-Cleveland Hotels. It proved to be a memorable evening of good fellowship as a large mining crowd enjoyed a superb dinner, an outstanding floor show, good music and dancing.

Ladies attending the Coal Show enjoyed three special events that were planned especially for them. At a welcoming luncheon on Monday they heard Mrs. Ivy Baker Priest, former Treasurer of the United States, give her views on "Women in Government." On Tuesday they visited General Electric's famous Lighting Institute at Nela Park and the Cleveland Museum of Art. Wednesday featured a luncheon at the beautiful Shaker Heights Country Club where the ladies enjoyed a novel presentation by Marthie Bouche of New Orleans, the "Madhatter," showing how to select a hat to fit a women's personality.

Two Field Trips

A special treat was offered Coal Show visitors on Friday—a chance to visit the Eastlake Station of Cleveland Electric Illuminating Co., or to tour Republic Steel's Cleveland Works.

C.E.I.'s Eastlake Station—the northern terminus of the famous coal pipeline from Cadiz, Ohio—is one of the most modern and highly automated generating plants in the world. Visitors were especially interested in the facilities at the discharge end of the pipeline, where the slurry is dewatered and the fine coal prepared for use under the boilers.

Convention-goers making the trip to Republic's Cleveland Works saw the world's ninth largest steel plant, visiting the open hearths, soaking pits, and the blooming and strip mills. They also inspected the unloading docks and the 2,000,000 ton per year coke plant. At the conclusion of the steel plant tour, the group had lunch while cruising on the Cuyahoga River and along Cleveland's waterfront. The trip afforded a good view of the city's industries and provided a fitting climax to a busy week of convention activities.

(For Reports on Sessions turn to page 73)

Coal consumption and production in the United States will show a slow but steady growth during the next 15 years

A Look at COAL'S FUTURE

By CHARLES J. POTTER
President
Rochester & Pittsburgh Coal Co.

ON June 6, 1957, at the annual meeting of the National Coal Association, speaking on the problems of the coal industry, I showed that coal consumption in the United States would decline to about 395 million tons in 1960 if it were an average year. Actual U. S. consumption last year was 397 million tons. These consumption figures include both anthracite and bituminous coal. I also said that about this time, if we were to have a bad business year, coal consumption would be as low as 360 million tons. It now seems that I may have been slightly optimistic and that consumption of coal in the United States in 1961 can be as low as 355 million tons unless business takes a substantial upturn during the last half of the year.

I have no desire to be catalogued by the coal industry as a harbinger of gloom and doom. Indeed it would be more pleasant, if the facts so warranted, to be numbered among the ranks of those optimists who continually expound the glad tidings of a billion-ton year. I am optimistic about the future of the coal industry; however, my optimism must be tempered with realism and it is in this vein that "A Look at Coal's Future" will be discussed.

The projections set forth herein are limited to the next 15 years.

I believe that 1961 will be the low point for coal consumption in the near future, and it would appear that the 1959–1960–1961 period should be the bottoming out period of coal's severe decline which has occurred during the past 19 years. In other words the industry should turn the corner by the end of 1961 and begin a slow but steady climb for 15 years with its usual ups and downs.

While the consumption of coal in the United States in 1960 was 397 million tons, it is believed that consumption for 1965, 1970 and 1975 will be 417, 443, and 479 million tons respectively. Including exports, this would mean production of about 510 million tons by 1975.

Let us now critically examine the reasons for the foregoing statements as to future coal consumption in the United States.

There are a number of different methods of projecting energy requirements, however, it is believed

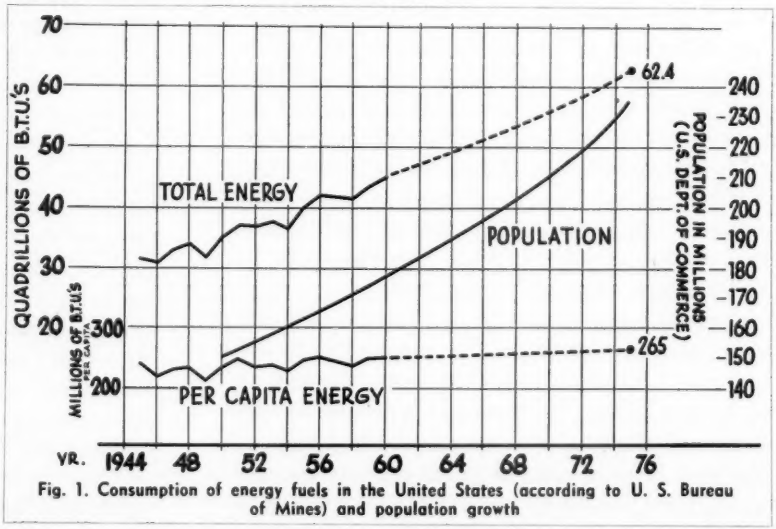


Fig. 1. Consumption of energy fuels in the United States (according to U. S. Bureau of Mines) and population growth

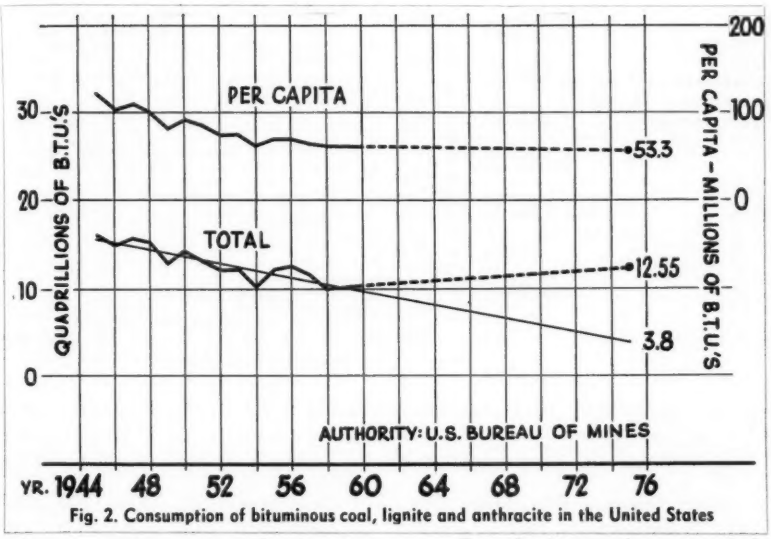


Fig. 2. Consumption of bituminous coal, lignite and anthracite in the United States

that per capita consumption is as reliable as any other method for such purpose.

Seven charts have been prepared showing various aspects of energy consumption in total and by individual sources. These will be discussed in order.

Figure 1 shows that per capita consumption of energy in the United States is increasing at a slow but relatively constant rate. The chart also shows the population projection of the Department of Commerce. The year 1960 was a good one for per capita energy consumption, it being, in fact, the second highest year in history. The chart also indicates that the variation in normal energy consumption can be as much as 76 million tons of coal equivalent. Heretofore, when consumption of energy declined, coal had to absorb most of that decline. Today, of course, with coal contributing less to the over-all energy supply it will not be forced to contribute such a large portion of any decline.

During a year when total energy consumption is relatively low, coal's decline may be as much as 40 million tons, whereas, during a good year coal could be 20 million tons above expected normal consumption.

Coal Production Should Exceed 500 Million Tons by 1975

What is ahead for coal? Figure 2 indicates that if the straight line trend continued, 1975 coal consumption would be down to 145 million tons. Fortunately, this cannot be true, as will be shown when we examine the expected markets for coal. In order to determine coal's markets in 1975 as well as the intervening years, it is necessary to study the expected requirements of the various coal consuming industries.

Electric utility industry. For the past ten years, the electric utility industry has been consuming increasing amounts of coal in the generation of power and has become the mainstay of the coal industry, having taken over that role from the railroads.

In 1960, for instance, the electric utility industry accounted for approximately 45 percent of the total U. S. coal consumption, and this was 176 million tons or nearly double the 1950 consumption by that industry. Indications are that the demand for coal by the utilities will continue to increase as the demand for electrical energy expands.

There have been many predictions as to the fuel demand by the utilities in 1975, based on expected electrical generation. To me, however, the prediction of power generation, made by the Federal Power Commission in August 1960, would appear to be the most reasonable. In this instance, the Federal Power Commission estimated electrical energy requirements for 1975 at 1716 billion kwh. Excluding hydroelectricity which supplies approximately 20 percent of the total, there would be some 1370 billion kwh to be produced from fuels. Significantly, if per capita generation of electricity based on the 1945–1960 trend is projected to 1975, it would indicate a total generation, by fuels, of 1371 billion kwh. The per capita use method verifies the Federal Power Commission figures.

In attempting to project coal demand by the utilities in 1975, consideration must be given to the continuing efficiency in coal consumption. According to the Federal Power Commission, it required 1.18 lb of coal per kwh in 1950, whereas, in 1960 the rate was 0.88 lb. Bearing in mind that this was the average for the entire industry, it means that some of the new installations were much more efficient than the average. In fact, it is known that some of the newest utility plants are rated about 8500 Btu per kwh or the equivalent of 0.65 lb of 13,100 Btu coal.

While the rate of improvement in the amount of coal consumed per kilowatt-hour is expected to continue, it will, no doubt, be at a slower rate than heretofore as it approaches the higher efficiency. Accordingly, I believe the rate of coal burned per kilowatt-hour by 1975 will average about 0.71 lb.

Applying this factor to the total expected generation of 1371 billion kwh would result in the consumption of 487 million tons of coal equivalent.

Today, of the fuels consumed by the utility industry in the generation of power, approximately 66 per cent is supplied by coal. However, the expected expansion in the utility industry as set forth by the Federal Power Commission shows the expansion between now and 1975 in the non-coal areas to be about 20 percent greater than that for the coal consuming areas. It is also my belief that the percentage of total generation by hydro plants will have decreased by 1975 from their present 20 percent. Stated another way, hydro can be expected to contribute less than its past share by the equivalent of approximately one-half quadrillion Btu by 1975. Therefore, the total for fuels by 1975 should be about 506 million tons of coal equivalent.

As mentioned heretofore, coal has been supplying about 66 percent of the fuels consumed by the utilities, however, it is my belief that by 1975 coal's share of this market may drop to about 60 percent. This drop will also reflect some nuclear generation by that time. Accordingly, it is my judgment that electric utility consumption of coal by 1975 will be about 305 million tons.

Coal for conversion into coke. In 1960, coal used for coking in beehive and oven coke plants amounted to 20 percent of total U. S. coal consumption.

The quantity of coal used for coking depends primarily upon the demand for pig iron, which, in turn, is governed by the demand for steel.

Here, as in the utility industry, efficiency of use affects the amount of

coal required. More efficient use of coke in blast furnaces has reduced the quantity of coke required per ton of pig produced. For instance, in 1949 it required 1896 lb of coke to produce a ton of pig iron. In 1959, it required only 1614 lb. The trend toward fewer pounds of coke per ton of pig will continue although its rate of decline will probably slow down. One factor in reducing the use of coke in the blast furnace is the injection of hydrocarbons or carbon which increases the yield of pig iron per ton of coke consumed. Taken all in all, it would appear that by 1975 the amount of coke consumed per ton of pig iron produced will be 1250 lb or less.

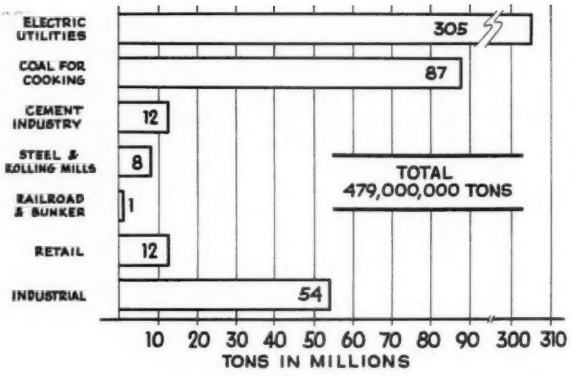
Projecting the per capita use of pig iron in the United States from the base period of 1943–1959 to 1975, it would appear that the consumption by 1975 will approximate 91.7 million tons. Applying the coke rate of 1250 lb to 91.7 million tons would result in requirements of 57.3 million tons of coke for blast furnace use in 1975. Using the conversion factor of 70.3 percent results in coal requirements for pig iron consumption in 1975 of *81.5 million tons*. In addition to coke for blast furnace use, it is expected that other coke uses will total about 4.0 million tons or the equivalent of 5.5 million tons of coal, thus making a total of *87 million tons of coal for coking by 1975*.

Cement industry. It is anticipated that the use of coal by the cement industry will increase at a relatively slow rate, it being governed primarily by the population increase. While the total coal consumption by this industry is relatively small, accounting for only two percent in 1960, nevertheless it is one of the growth industries so far as coal use is concerned and by 1975 is expected to total *12 million tons*, as contrasted with 8.2 million in 1960.

Steel and rolling mills. Here, as in the case of the cement industry, demand for coal should increase slightly due to the expected increase in demand for steel products. The increase however is expected to be modest and total use is estimated at *8 million tons in 1975* as against 7.4 million in 1960.

The four industries just discussed comprise the only growth industries so far as coal consumption is concerned. The following represent the declining user classes.

Railroad fuel and bunker coal. Little need be said about these two classes of consumers. Oil has taken over. Further, it is believed that coal for railroad and bunker use will continue to decline, and by 1975 may be as low as *one million tons* or less, as compared with about 3 million tons in 1960.



Retail. Gas and oil have taken away most of the domestic heating markets formerly had by coal. However, gas and oil cannot take all of coal's domestic markets any more than coal could take over all of the wood consumption. So far as the heating of apartment houses, hospitals, schools, etc., is concerned, the big item of cost to the consumer is labor and with continued inflation, resulting in increased labor cost, further losses to oil and gas can be expected.

Recently, much has been said about home heating by electricity and the possibility of the coal industry regaining some of its retail business indirectly through this medium. Even though this is correct, there will still be a net loss to the coal industry due to the efficiency in the generation of the power to heat homes as contrasted with direct coal heating.

It is expected that retail coal deliveries will continue to decline and that by 1975 it will amount to approximately *12 million tons*, as compared with about 36 million tons in 1960.

Industrial and manufacturing. In the industrial markets coal has been severely hurt by oil and gas. This is particularly true in the densely populated and highly industrialized eastern half of the United States.

Fuel oil is now being trucked inland 150 miles from the eastern seaboard with the result that industries such as laundries and small processing and manufacturing plants, where fuel labor costs are high, find it cheaper to use competitive fuels.

The use of higher demand and of lower energy charges for gas will permit the dumping of natural gas to industries during the summer months. Further, the rate of industrial growth in the non-coal consuming areas is expected to be greater than that in the coal areas as a result of further shifts of industry from coal consuming areas.

Some industrial plants that now produce their own power will, no doubt, change to purchased power, resulting in a further decline in coal's use because less coal is required in the new modern utility plants than in the older and less efficient industrially owned power plants.

While this particular consumer category utilized slightly over 19 percent of the total coal consumed in 1960, there has been a decline in total coal consumption for the past 15 years, even though some of the coal use has shifted to the utility category. It is expected that decline in coal use, by industrials, will continue but the rate of decline will slow down. It is my belief that by 1975 coal consumption in this use category will total *54 million tons*, compared with about 76 million tons in 1960.

To summarize, minimum coal consumption in the continental United States by 1975, will, in my opinion, be as follows (also see above chart):

	Million tons
Electric utilities	**305**
Coal for coking	**87**
Cement industry	**12**
Steel and rolling mills	**8**
Railroad and bunker	**1**
Retail	**12**
Industrial	**54**
TOTAL	**479**

To the 479 million tons of U. S. coal consumption for 1975, expected exports must be added to arrive at production. If one assumes that exports will be about 30 million tons, with 10 million for Canada and the balance overseas, total production of coal should exceed 500 million tons by 1975.

Referring again to figure 2, it will be noted that the consumption curve, based on the expected market for coal, gives 12.55 quadrillion Btu's or the

equivalent of 53.3 million Btu per capita. These figures when converted to tons of coal consumption amount to 479 million tons. Compared with 1960, this means an increase of 82 million tons in 15 years or an average increase of about 5.5 million tons per year. This forecast is not as optimistic as you would like to hear, nevertheless, it shows U. S. coal consumption moving upward for the first time in many years.

Oil, Gas and Hydro—Growth Rate Must Decrease

That the coal industry will continue to share in the energy market can be demonstrated by reference to figure 3.

This figure shows that on the basis of per capita consumption, if oil, gas and hydro continued their present growth rate, they would take over the entire energy requirements of the United States by 1972. This is obviously impossible; therefore, there must be a reduction in the growth rate of these energy sources. Economics of distribution are such that it would be impossible, for instance, for oil and gas to take over all of the utility business. Further, it is evident that coke, for the production of pig iron, will not be entirely displaced within the next 15 years. In fact, new blast furnaces are now being built.

Figure 4 shows the decreasing rate in the per capita consumption of oil, gas and hydro that will occur by 1975. However, total growth rate of these sources of energy will continue to average about three percent per year for the next 15 years as contrasted with an average eight percent per year growth for the past 15 years.

Figure 5 sets forth the energy picture for water power and shows that, while there has been a minor growth rate in total consumption over the past 16 years, the per capita rate has been declining. It is anticipated that the per capita rate will continue to decline although total consumption will increase slightly. It will be noted from the chart that by 1975 total consumption is expected to be *2 quadrillion Btu*, the equivalent of 76 million tons of coal.

Figure 6 shows past and expected future use of natural gas and natural gas liquids in the United States. Natural gas is the strongest competitive fuel in the energy market. The gas industry has the ability to make two-part rate structures, it has the lowest transportation charge and its prices at the wellhead are, in effect, regulated by the Government. On the other hand, the delivered price of gas is in-

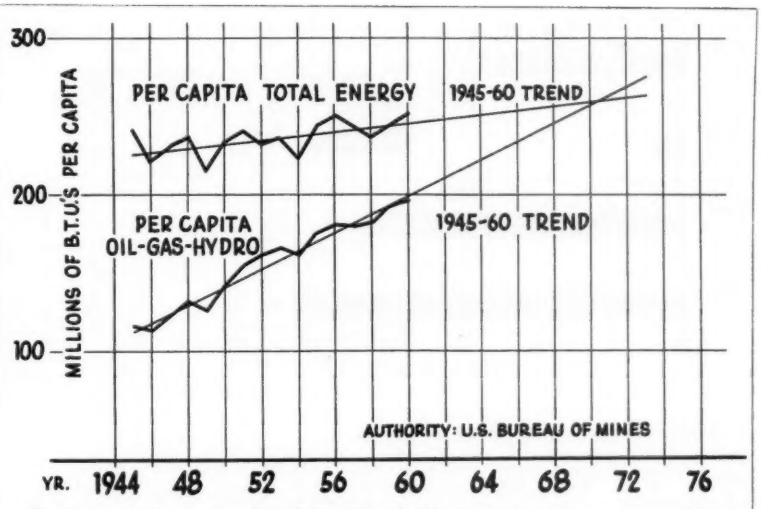


Fig. 3. Per capita consumption of energy in the United States—total versus combined oil, gas and hydro

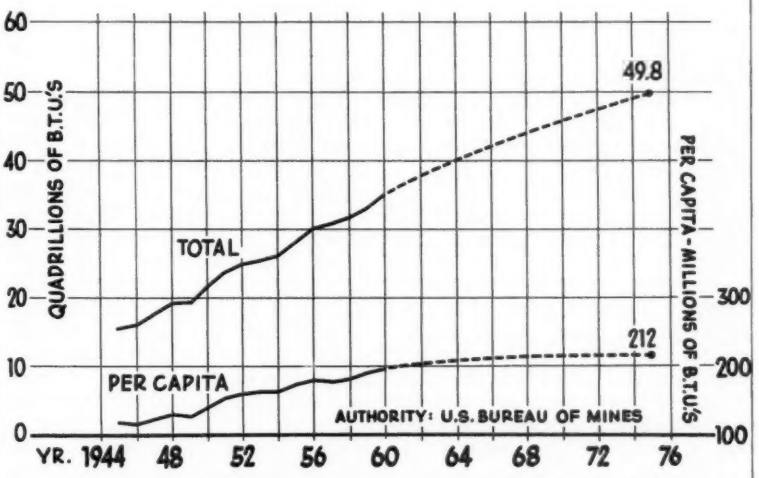


Fig. 4. Consumption of oil, gas and water power, combined, in the United States

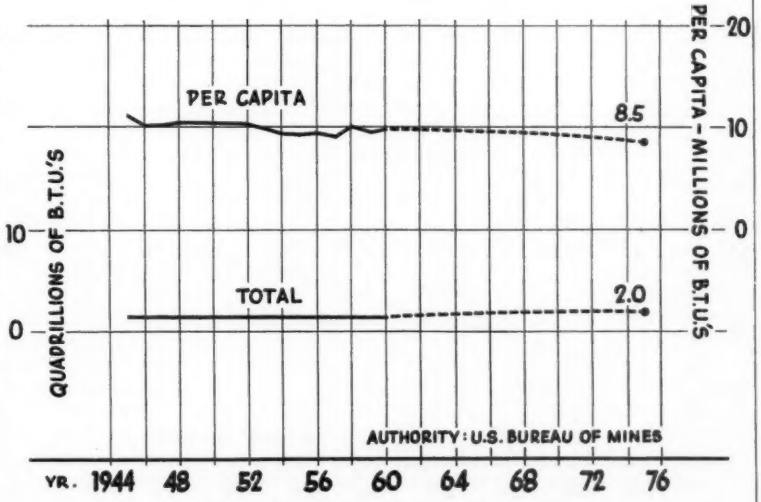
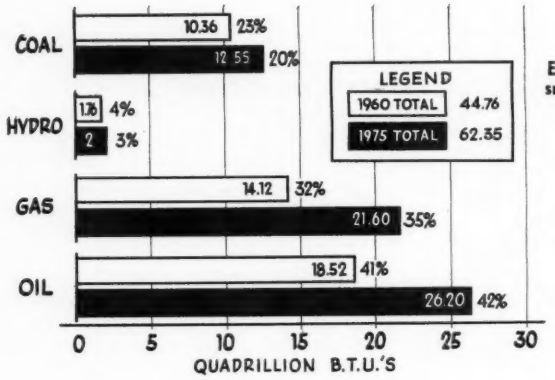


Fig. 5. Consumption of water power in the United States



Expected energy consumption in 1975 by source

creasing at a faster rate than other fuels and its reserves are depleting faster than the discovery rate. This is not true of oil.

While there appears to be ample gas supply for the next 15 years, figures indicate that at the rate of consumption expected by 1975, the reserves will be down to about 17 years supply. Thereafter, unless there is some drastic change in the rate of discovery, not only will its growth rate cease but its reserves will deplete at an accelerated pace.

Further, the cost of gas must continue to increase as the cost of exploration and drilling increases. This increasing cost is expected to be greater than that of coal because of further increased productivity in mining. Even with greatly improved drilling and exploration methods, it is not conceivable that rates of gas discovery beyond 1975 will be nearly as great nor as economical as heretofore. Thus, even allowing for gas importations, by 1975 coal should be able to compete for industrial markets which are presently being taken over by gas, especially off-peak gas. Referring again to the chart, it is believed that gas consumption by 1975 will not exceed *21.6 quadrillion Btu*. This is the equivalent of about 820 million tons of coal.

Figure 7 shows the per capita and total consumption of oil and petroleum products in the United States for the period 1945–1960, as well as expected consumption in 1975. Although the chart shows a fairly steady growth, it is believed that its rate of growth must slow down considerably by 1975. In fact, for the past 12 years the rate of gain in demand for petroleum products, including residual, has shown a steady decline. This confirms previous statements I have made, that the rate of gain by oil and gas must decline because there is nothing in sight in the domestic economy of this country which will change this trend. In other words, there are no large new consumer classes coming into the oil supplied energy market such as automobiles or railroads, which would support former rates of gain in demand for this fuel. It is believed that so far as oil and petroleum products are concerned, consumption by 1975 will be about *26.2 quadrillion Btu's*, or the equivalent of slightly over 1 billion tons of coal.

Table A

Energy Source	Quadrillion Btu		Percent	
	1960	*1975*	*1960*	*1975*
Coal	10.36	12.55	23	20
Hydro	1.76	2.00	4	3
Gas	14.12	21.60	32	35
Oil	18.52	26.20	41	42
TOTAL	44.76	62.35	100	100

The above table summarizes expected energy consumption in the United States, by sources, for 1975, as compared with actual consumption in 1960.

It will be noted that coal's percentage of participation in the total energy market in 1975 will represent a further decline from the present day figure, although total energy consumption will increase, as will actual tons of coal consumed.

Nuclear Generation Considered

By 1975 there will be many areas in the United States where the lowest cost fuel will be enriched uranium, assuming a continuation of government subsidy in the form of the purchase of used reactor material. Indeed, based on today's prices the cost of uranium-produced energy could be in the area of 33 cents per million Btu in the not too distant future. Such an event would mean that coal must keep its delivered cost below 33 cents per million Btu to its major utility markets or find itself priced out of that market. It is expected, however, that even by 1975 the total inroads of nuclear energy into the fuel business will not be substantial in terms of total energy consumption.

In my 1957 presentation before the National Coal Association, speaking of the attainment of a 500-million ton market for coal in the United States, I said:

> "The attainment of that goal is not impossible but most difficult. We cannot afford to sit by and wait for the market to come to us. We cannot rely on the optimistic predictions of others, including those of our competitors. The struggle we face is a most difficult one, but it is not insurmountable."

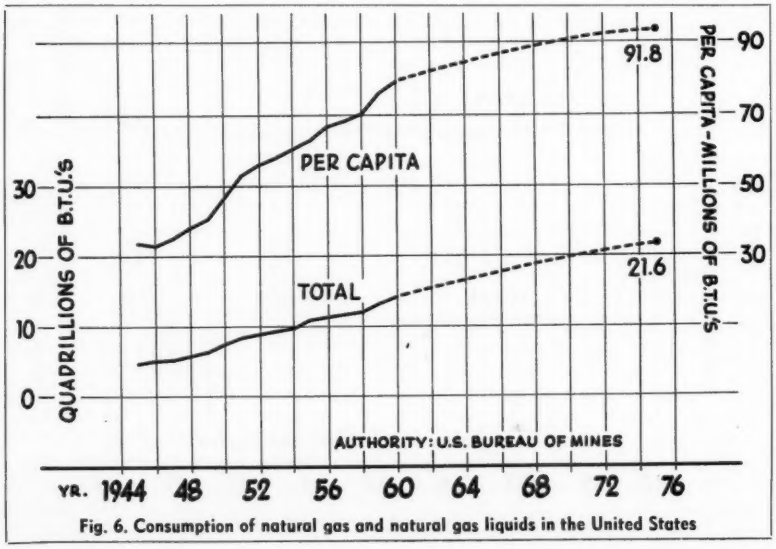


Fig. 6. Consumption of natural gas and natural gas liquids in the United States

There is nothing in sight today which would cause me to alter that statement. Our goal is still a 500-million ton market in the United States and the problems standing in the way of attaining it are just as difficult today. Yet, they are not insurmountable.

Delivered Cost of Coal Must Decrease

To attain the 479 million ton domestic market expected by 1975, the cost of coal must not increase in relation to the cost of competitive fuels. In fact, the delivered cost of coal must decrease.

Inasmuch as the delivered cost of coal is made up of three factors, cost of production, quality and transportation, let us examine these factors in the light of our competition and our expected 1975 coal market.

Cost of production. It would appear that there is little possibility for great reductions in the cost of production between now and 1975. Most of the increase in tonnage will be from deep mines where the cost is substantially higher than that of strip mining. This is particularly true in the Appalachian area. Increased productivity will be helpful toward reducing production costs but further reductions will come at a slower pace than heretofore. Further, while some increase in productivity is still possible, a great portion of the savings thus made is offset to a greater degree by increased maintenance and capital cost. Coal will continue to use a great deal of labor and inflation is continuing.

The coal industry requires major research in new systems of mining. New and better equipment is required particularly from a maintenance and capital cost standpoint.

Quality. There must also be devised methods by which the cost of cleaning and drying coal can be substantially reduced or coal's utilization must be at or near the mine as raw coal.

Transportation. The following methods, or combinations, are utilized in transporting coal to market: water, rail, truck, pipeline or coal converted to energy and shipped by wire.

Water transportation is still the cheapest method. Therefore, all possible aid should be given by, and to the coal industry in developing water routes or combinations of routes utilizing water transportation. This requires additional river facilities and canals as well as joint rail-water combination routes and rates.

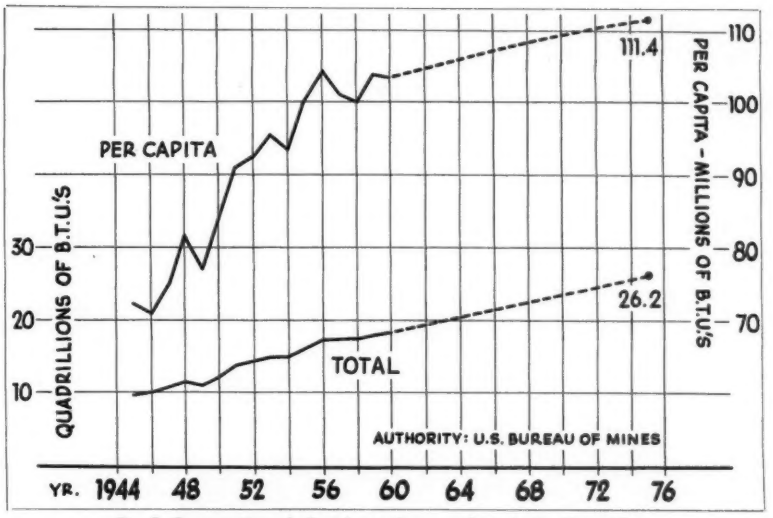


Fig. 7. Consumption of oil and petroleum products in the United States

Railroad freight rates must be reduced to more nearly approach the actual cost of coal rail transportation. This is especially true on hauls of up to 400 miles. The coal industry should continue to assist the railroads in their attempt to eliminate uneconomic services. The railroads should also have assistance from the coal industry in attempting to relieve them of the burden of discriminatory taxes at all political levels.

Truck transportation has limited application, being governed primarily by the geographic location of consuming points in relation to producing fields. Truck transportation of coal for distances up to 200 miles is now taking place. This, together with much short haul truck coal, is one of the competing forms of transportation which has caused the railroads to reduce their rates.

Pipeline transportation requires large users. Long term contracts and large coal reserves are as necessary as is large constant tonnage movement. The feasibility of the pipeline has been demonstrated and the cost is known. At present the cost of pipeline transportation on large tonnages is estimated to be about 70 percent of the rail rates for distances up to 400 miles. More pipelines for the transportation of coal will be built unless there are substantial reductions in railroad freight rates or other means found to reduce transportation charges.

Transportation by wire is becoming more important as the delivered cost of fuels increases. At the present time 450 or 750 thousand volt lines are being tested in this country and indications are that the cost of transmitting power for substantial distances by wire will approximate the coal equivalent of six to eight mills per ton-mile. This is just half of the present transportation costs to most Eastern public utilities.

As pointed out in 1957, to fully utilize transportation by wire it is necessary to develop ways and means, by legislation if necessary, to permit joint participation in building large generating plants at or near coal fields and to permit the pooling of power between companies for use in other states as well as in the state where the power is generated. The coal industry has done nothing about this.

Government Must Restrict Excess Imports of Residual Oil

The coal industry requires the assistance of the Federal Government in setting forth a national fuels policy. The Government must restrict excess imports of residual oil because of the major effect of this competition on price. Excess imports of residual oil are sold at prices $4.00 per ton less than coal as contrasted with prices $4.00 per ton above coal in periods of oil shortages.

In conclusion, may I suggest that first, we must make certain our own house is in order by continuing our efforts to produce coal more economically; second, we use every possible means to assure coal, or its available energy, transportation to market at the lowest possible cost; and, third, there be no relaxing in our efforts to overcome the forces of unfair competition from competing domestic and foreign energy, even though the battle leads us to seek Congressional or other governmental assistance.

EXPLOSIVES

ENERGY...

vs. Mechanical Energy

Cheaper blasting materials and improved drilling equipment have reduced the cost of explosives energy to the point where it is doing work formerly reserved for mechanical equipment. By putting more of this low-cost explosives energy to work, machinery operates more efficiently, costs are lowered all along the line.

Smart, profit-minded operators are taking a closer look at the cost of mechanical energy vs. explosives energy and they are coming up with important savings in machinery, manpower, and time—for example:

In coal stripping, explosives force is used to move up to 50% of the overburden directly on to the spoil pile. Mechanical handling costs are reduced, and coal is uncovered more rapidly.

In open pit ore mining, explosives factors are being designed to gain additional fragmentation. Much of the material by-passes the primary crusher. Production is speeded, overall costs lowered.

In quarrying and construction, operators are finding it no longer pays to blast rock just hard enough for equipment to handle it. They are taking advantage of lower drilling and blasting costs to gain more fragmentation and displacement. And in the process they are making important savings in wear on crushers, dipper teeth, wire rope, and truck bodies. They are reducing operating costs, eliminating production delays.

The economics of drilling and blasting have changed. Looking for ways to reduce blasting costs alone is not enough. The real savings come when you look at explosives energy as a way to reduce overall operating costs.

For a closer look at some of the ways explosives energy can lower your costs all along the line, look to Atlas' full line—the only full line in the industry. Expanded plant facilities are now in production at Joplin, Missouri to assure ready availability of all products. And to give you faster, more flexible local service, new distribution facilities are being established coast to coast. Call in your Atlas Representative. His experience with the newest advances in explosives, blasting agents, and blasting techniques can help you measure the relative economy of explosives energy vs. mechanical energy in your operation.

ATLAS POWDER COMPANY
Explosives Division · Wilmington, Del.

ATLAS EXPLOSIVES

← Using explosives energy to cast overburden to spoil pile at a large Midwest coal stripping.

Maintenance of open pit equipment

Decisions made at every level of management affect maintenance costs—a fact that is often overlooked

By R. Y. JENSEN
Assistant Chief Engineer
The M. A. Hanna Co.

ALL mining men would undoubtedly agree that maintenance materials and labor are a substantial part of production costs. They are well aware of the capital expenditures required for inventory and spare equipment to minimize costly maintenance delays that interrupt scheduling and reduce revenue through production losses.

It is easy to recognize and anticipate the tangibles of maintenance—normal wear on equipment, the effects of abrasion and impact, the fatigue of critical parts as imposed by the peculiarities of the specific operation. But of greater long-term significance are the intangibles which have an indirect but very substantial effect on costs. These intangible forces are shaped—for better or for worse—by decisions made at every level and in every department of an operating company—from the pit operators to top management.

Decisions regarding sales, production, finance, industrial engineering, planning, purchasing, and all the other management responsibilities, very often bear directly on maintenance costs. This is often overlooked by people who regard their activities as being considerably removed from maintenance in the pit. All levels of management must add a new dimension to their thinking; they must begin giving major consideration to maintenance in every operating decision they make and policy they establish.

Some specific examples of responsibilities at various levels of management will show how they relate to the subject under discussion.

The Foreman's Responsibility in Maintenance

One basic responsibility for maintenance lies, of course, with the pit foreman. He has a great many production matters to attend to in the course of his day, from programming next week's drilling to upholding today's truck production.

Most important of all, the pit foreman is the company's intimate contact with personnel, and as such he is inescapably assigned a fundamental responsibility to maintenance—a responsibility that has become increasingly difficult to fulfill because of management-union relationships. Reference is being made to the foreman's responsibility for proper operator attitude, adequate training of personnel, and the enforcement of good operating and servicing practice.

An operator attitude of pride and concern for his equipment does not develop by accident. It must be deliberately generated and continuously cultivated. The foreman, with conscientious help from the rest of the

company, can improve and sustain attitude. Pride in machinery can be instilled by an unrelenting program of good, orderly housekeeping. Abuse and carelessness can be virtually eliminated by refusing to tolerate it. Immediate attention to reports of machinery difficulty and action to remedy the trouble convince an operator that his judgment is respected and that maintenance is of vital importance. Operators will in time reflect the attitude of their foreman.

A foreman whose every-day actions and attitude display his conviction that only good machinery, properly maintained and operated, will give the best all-around costs, will eventually be rewarded by similar attitude in his men. The foreman's attitude usually is formed at a high level in the company, for he reflects the attitude of the superintendent; the superintendent reflects management, and management reflects the attitude of top executives and directors.

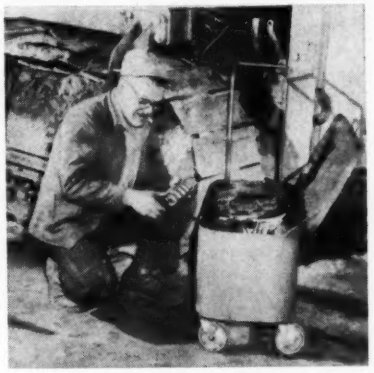
Unfortunately, on the other hand, the good attitudes built by a training program and by conscientious foremen can be seriously damaged by company actions with which all operators are familiar. As operating companies, how many times have we been guilty of yielding to demands for production that mean forsaking good operation? How many times have we condoned poor equipment housekeeping in our impatience to make a schedule? How often have we displayed a negligent attitude by keeping equipment in production that should be laid up for repair? How often have we promoted capable but inexperienced men to the vital role of foreman without having trained them thoroughly in our programs? How often are we tempted to resign ourselves to the negative assumption that we can no longer do anything to improve operators' attitudes because they have aligned themselves with an organization that often seems to work against the company and its well-being?

If we continue yielding periodically to such temptations as these, the prospects for bringing any lasting improvements seem very slight. The best maintenance department and its program can never be really effective when operators have a "who cares" attitude.

Scope of Maintenance Department Activities Broad

Now let us look for a moment at the maintenance department itself. Maintenance people can no longer be content with the establishment of a maintenance program and the servicing and repair of equipment. Their horizons must be extended to include programs for the improvement of existing equipment and the development and testing of new machinery.

Tangibles of maintenance, such as normal equipment wear, effects of abrasion and impact, and fatigue of critical parts, are easy to recognize and anticipate. It is, however, the intangibles that are of greater long term significance—decisions made at every level and in every department shape these



Immediate attention to reports of machinery difficulty, and action to remedy the trouble, convince an operator that his judgment is respected and that maintenance is of vital importance

The results of these programs, along with the experience and recommendations of the maintenance department, must become a vital consideration at all stages of any project planning.

Programs should be initiated to study machinery component failures. Reason for failure should be made known to those responsible for operating the equipment. A repeated failure should bring immediate investigation to change operating practice or to improve design. These findings, reviewed with the equipment manufacturer, are necessary to the development of still better equipment. The basic concept and design of a machine may originate on the drawing board, but its refinements and component improvements must come from field experience and recommendations.

There should be an unending quest for improved materials, such as better seals and bearings, tougher abrasion-resistant stronger alloys steels, longer life wire ropes, better lubricants, and so forth; the list is endless. Furthermore, these should be carefully evaluated under a controlled program of field testing, supported by a system of records that will make the results meaningful.

Cooperation with Manufacturers Important

Manufacturers should be encouraged to build machinery designed to facilitate repair and overhaul. Parts requiring frequent servicing, inspection or lubrication should be easily accessible. Unitized design should be pursued; this enables entire units to be quickly replaced in the field and unit component repair carried on under favorable shop conditions away from the pressure of production. Without a doubt, any operator would be exasperated by the sight of a $60,000 truck rendered useless during repair of some $25 component that could not be quickly removed for repair and replacement.

A willingness to cooperate in field trials of new or better equipment encourages manufacturers to improve equipment design. Purchase orders placed for improved equipment as reward for the originator's research, initiative and expenditure are even better encouragement. Supervisors should realize that no design is ever completely satisfactory or final and that they can always contribute to equipment improvement.

It's ironic that familiarity with

existing equipment and the parts inventories, that are vital to good maintenance, should be so often the same two factors that forestall a change to new or improved equipment that could greatly reduce overall cost and effort. Efficient, alert maintenance departments making use of a complete system of records can be sure of the actual improvements derived from material and design changes. Information of this type helps convince management that improved equipment will reduce maintenance cost to compensate for the effort spent retraining skilled personnel and the money invested to increase inventory.

How Purchasing Policies Affect Maintenance Costs

Let's look now at the purchasing department. Here is a prime source of intangibles that affect maintenance cost.

Equipment manufacturers are really our partners. Their cooperation in improving design and developing larger, more efficient machinery has bettered our profit margins and increased our reserves. They have given us important help in living with the increasing demands for higher wages and for a better product. To many manufacturers, a company's personality is revealed only by the purchasing department.

The atmosphere of purchasing negotiations can greatly influence the cooperative attitude manufacturers will display in servicing and improving their equipment. A manufacturer who has been negotiated out of a reasonable profit is rarely in the mood, or financial position, to cooperate enthusiastically in equipment improvement or render good field servicing.

Purchasing directors should continually examine the possibility of purchasing from reputable local distributors. Often the company realizes substantial inventory savings and a reduction of equipment downtime. Frequently, a local representative is in a better position to give prompt service than a manufacturer in a distant city, and may have just a little more incentive to give the best service. Purchasing departments should not forget that this dealer's inventory has cost him money and therefore he cannot always be competitive with cut-price firms who offer no local service and carry no available protective inventory.

Purchasing departments must maintain a constant liaison with the maintenance department. No machinery, or construction material, should ever be purchased without the recommendations of maintenance people. No replacement parts should be ordered without first checking records of past performance and field changes. Purchasing to price alone is apt to be penny-wise and pound-foolish unless items are thoroughly reviewed with the mechanical and electrical maintenance departments.

These are intangibles that have a very real effect on the long-range maintenance picture.

In the final analysis, the responsibility for the entire operation and the success of all the programs, practices and policies that have been discussed lies in the hands of the operations manager, his superintendents and the operating staff.

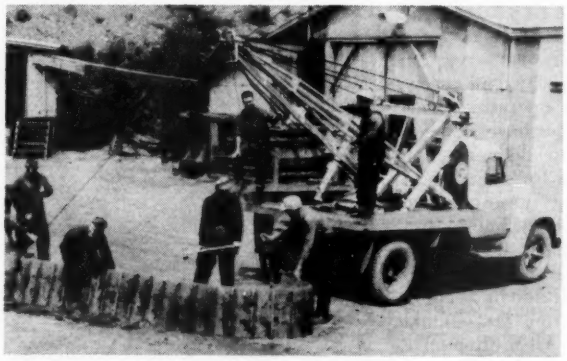
Because of the scope of decisions made and plans formulated at this level, the intangible contributions to maintenance are of even greater significance.

Planning flexibility into pit operations usually requires additional capital but always pays real dividends in maintenance cost. For example, locating substantial surge piles of product between different phases of production permits maintenance when required, rather than when possible, and allows more thorough maintenance by alleviating production pressure. An alternate stripping dump area of minor capacity will allow temporary re-routing of traffic to permit really effective road and dump surface maintenance.

Timing is vital. The operating staff owes it to the rest of the organization to plan ahead and anticipate, for to ask for changes in production or pit development without forewarning results in random, panic operation that is incompatible with good maintenance.

Plans for new pit developments, or substantial extensions to existing pits, or increasing production rates must give ample consideration to maintenance. The superintendent and his mining department should take full advantage of the experience and developments of the mechanical and electrical departments by permitting them to study plans and select the best available equipment. This equipment should have characteristics best suited to fit the method of mining and stripping, the nature of the material, the dictates of the climate and contours of the pits, dumps and haul roads. Only quality equipment best suited for the particular job will yield lowest maintenance cost.

Yet to fit equipment to the job is no longer adequate planning. The improvement in design and the astonishing variety of earthmoving equipment that has been developed and proved in the past decade makes it imperative that serious consideration be given to how pit design and mining method might be changed to fit



A component failure should be studied and the reason for failure made known to the operator. Repeated failure should bring immediate investigation to change operating practice or to improve design. These findings, reviewed with the manufacturer, are necessary to the development of better equipment

Planning Flexibility in Pit Operations

Laying out an open pit operation, or planning an extension, calls for continually weighing development costs against anticipated maintenance cost of the proposed operations.

Stripping volume and cost simply cannot be allowed to become the only influencing consideration in haulroad location and design, bench width and cut depth or drainage patterns. Haul roads which must be continually relocated do not warrant proper initial construction or lend themselves to good upkeep. Sharp curves, steep grades and roads built on poor material to avoid a little extra stripping, lead to high truck costs for the life of the operation. Stripping saved is a poor trade for an inadequate sump and drainage pattern that can only mean operating in mud and water every time it rains.

improved equipment that is currently available.

Operating management should remember this one simple fundamental —because it is of such importance— planning and equipment selection should be completed before they commit themselves to a budget—not set a hasty budget first and have it dictate inferior planning and compromise equipment selection.

Responsibilities of Management Are Many

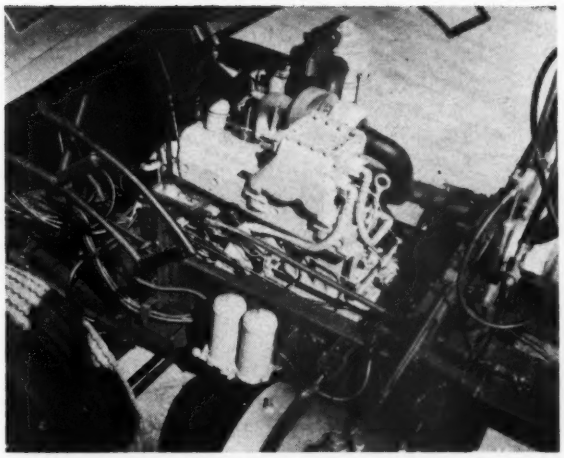
The discussion of budgets for expansion or new development leads to the matter of company management and their responsibilities to maintenance. They have many other cares. Market analysis, sales, financing, long-range planning, future reserves, competitive standing and selection of personnel are just a few of the responsibilities they dare not neglect if the company is to survive and flourish.

With responsibilities of this scope and importance, it is understandable that management can inadvertently make decisions without proper consideration of their influence on equipment maintenance. Reviewing budget planning and scheduling with the staff of the operating department to aid in decision-making assures due consideration of operating and maintenance problems.

Any radical change in production requirements without forewarning downgrades the best maintenance programs. Delaying decisions to authorize new developments or expansion shortens the time required for good study, planning and proper equipment selection. Hastily assembled budget figures, derived from previous projects and experience, tend to dictate planning and equipping a new operation the same for the increasingly competitive future as they were, right or wrong, in the past.

Decisions Should be Timed

Cutting budgets and curtailing operations to meet abnormal seasonal market fluctuations, without authorizing overhaul and repair of idle equipment, means expensive, difficult maintenance problems later when the market requires high production to catch up. Seasons have a direct effect on maintenance, and temporarily curtailing an operation in summer that must be resumed in winter causes completion of that job with increased maintenance cost and problems. By the same token, management should time decisions to initiate development and construction in the most favorable season.



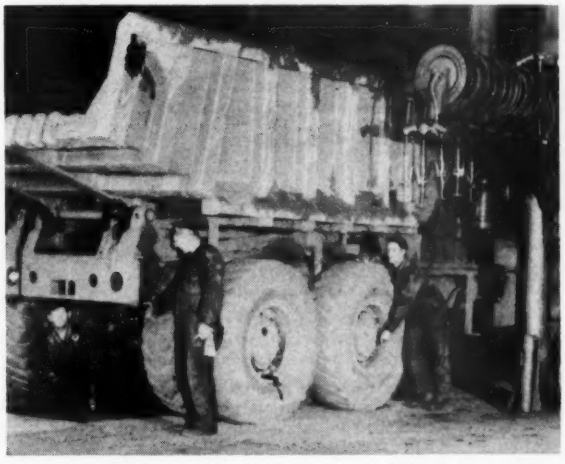
Manufacturers should be encouraged to build machinery designed to facilitate repair and overhaul. Parts requiring frequent servicing should be easily accessible

Management reluctance to spend dollars which show no immediate or tangible return discourages research and evaluation of improved equipment. This same reluctance usually cuts inventories too low for a good maintenance program and may deny the tools, space and working conditions that are vital if the shop is to function properly. Management should realize that some recommendations for expenditure to improve operating conditions are impossible to evaluate in dollars of direct saving.

When management employs outside consulting and engineering help without spelling out in detail their responsibility to review plans and equipment specifications with the operating and maintenance departments, they are often wasting many years of valuable experience that is available right in their own company. Even worse, this may reduce incentive to pursue equipment improvement programs.

The merits of these statements seem obvious, and yet many of us have contributed to or witnessed decisions made in urgency without consideration being given to present and future maintenance. This article has reviewed just a few of these intangibles, discussing the vital importance of proper attitude and the need for a definite program to generate and maintain it. The wider scope of the mechanical and electrical departments to include real programs for equipment improvement has been reviewed. It has been stated that purchasing policy and practice affect cooperation to improve equipment; that hasty planning and slim budgets rarely produce a low maintenance cost project, and that top management must consider maintenance in their decisions, budgeting and programming.

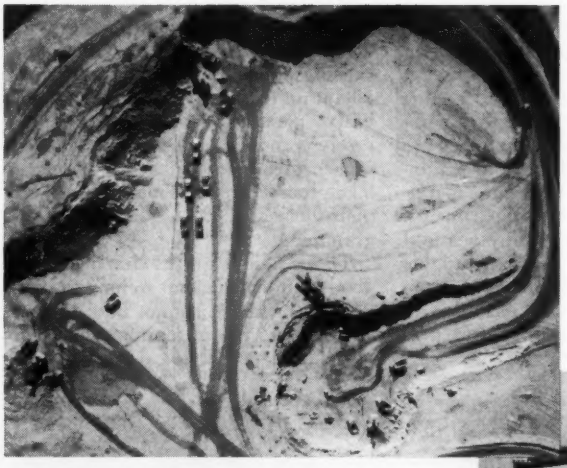
These points are so important to good maintenance that so long as they are overlooked it cannot be said that an adequate job of maintaining open pit equipment is being done.



Planning flexibility into pit operations permits more thorough maintenance by alleviating production pressure. This usually requires additional capital but always pays dividends in the form of reduced maintenance costs

Aerial view of the Mission project of American Smelting & Refining Co. near Tucson. Eventually some 50,000,000 tons of overburden will be removed. The pit depth is now at the 210-ft level

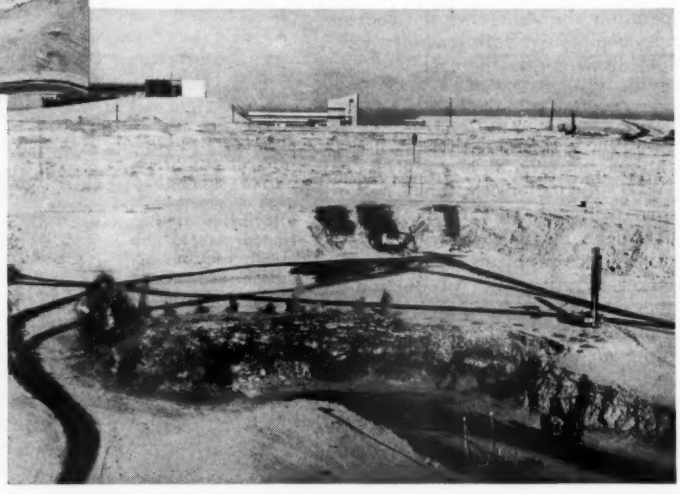
Mission Project Forges Ahead



Ten tons of powder in 20 holes are ready for the daily blast at the Mission pit

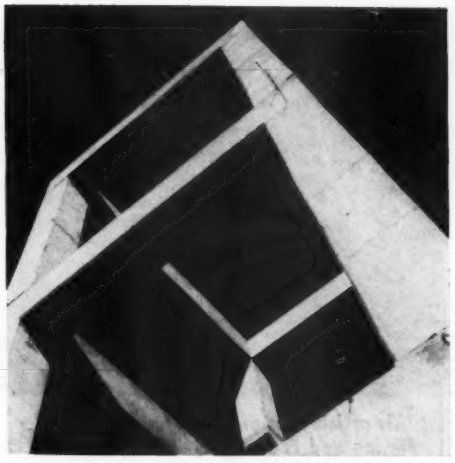
NEARLY 40,000,000 tons of overburden have now been removed from the pit at the Mission property of American Smelting & Refining Co. near Tucson, Ariz., where Asarco is developing an open pit mine and building a concentrator that is scheduled to produce about 45,000 tons of copper annually when completed.

Development of the property follows exploratory work begun in 1954 which consisted in part of extensive drilling to determine the extent and grade of ore deposits. A 375-ft shaft was subsequently sunk to check results of earlier drilling, and to take large samples for mill pilot-plant test work.



A ten-ton blast breaks loose overburden and exposes ore which is being stockpiled in anticipation of the new mill's completion (background)

Fifty-five ton capacity trucks being loaded at the 210-ft level, where ore is beginning to show. Ore is being stockpiled now that the mill is in its final stages of construction



This concrete and steel transfer tower will support conveyors from the primary crusher at the mill site

The area of the pit as presently designed covers about 250 acres that adjoin properties of Pima Mining Co. and Banner Mining Co.

Eventually some 50,000,000 tons of overburden will be removed from the pit which has now reached the 210-ft level where ore has been uncovered. Ore is being stockpiled in anticipation of completion of the 15,000 tpd mill, which is being engineered and built by Western Knapp Engineering Co.

In 1960, Asarco spent $19,500,000 on the project. Total cost has been estimated at about $43,500,000.

Last year miscellaneous service buildings, including the machine shop, warehouse, change house and a seven-mile railroad branch were completed. At year's end, installation of major equipment and construction of a power line had started. Estimates are that the completion schedule should be bettered by several months.

The mill site of the Mission concentrator is flanked by nearly 40,000,000 tons of overburden removed from the pit

Work is nearly complete on the 15,000 ton capacity fine ore bin where workmen are installing feeders in the buckle-plate steel and concrete storage bins

The 70-ft mound in the center foreground, sometimes referred to as Scheicks Peak, supports water tanks with a capacity of 600,000 gal each to supply water for the concentrator below. The mound was built up from pit strippings. Conveyors will connect the primary crusher (lower right) with crushed ore stockpile, the secondary crusher building (right of center) and the mill building in which much of the grinding and flotation machine installations are complete

Application of diesel units underground

This article was prepared by the Mining and Engineering Staff of Tennessee Coal & Iron Division, U. S. Steel Corp., Fairfield, Ala., as a paper for the 1961 Coal Show of the American Mining Congress. The paper was presented by Peter J. Zukow, superintendent, Mines No. 7 and 8, Ore Mines & Quarries, Tennessee Coal & Iron Division.

Tennessee Coal & Iron Division of U. S. Steel Corp. is successfully using diesel shuttle cars and other diesel equipment in its ore and limestone mines under conditions similar to those found in underground coal mines. Management predicts use of diesel equipment will continue to increase because of its mobility, efficiency and safety

WHEN a change was made to a new system of trackless mining in the ore mines of the Tennessee Coal & Iron Division of U. S. Steel Corp. in 1947, there was very little experience to base the division's requirements on except the information that could be provided by the coal mines. Mechanization of TCI's coal mines preceded that of the ore mines by several years.

The first shuttle cars were of the cable-reel type, and were satisfactory as a start for mechanization and trackless mining in the ore mines. However, the limitations of cable-reel shuttle cars soon became apparent, and thought was given to overcoming these limitations with a different type car.

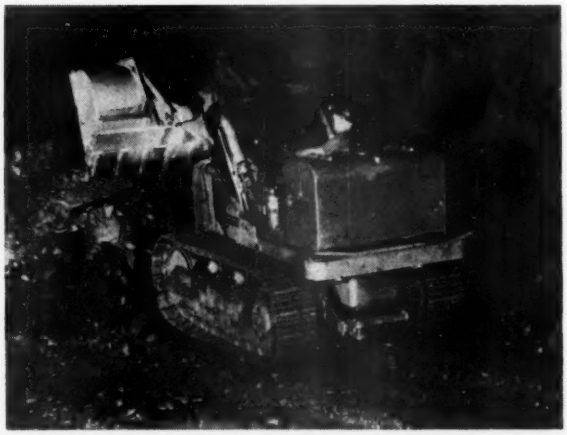
Diesel-Electric Units Tried First

TCI's experience with diesel shuttle cars began in June 1951 when three diesel-electric shuttle cars were purchased for use in its underground limestone mine. There the ventilation was more than adequate for the operation of diesel engines. These three cars, which are still in service, have a two-cycle, direct injection, 82-hp engine which in turn powers a 50-kw generator. This car was designed in accordance with the Bureau of Mines Schedule 24 for Diesels in Non-Coal Mines and represented a major step in the development of underground rubber-tired vehicles. The major advantage of this type car is its self-contained power plant.

All the limitations and problems associated with a cable reel were eliminated, including restricted length of run and route of travel. Capacity is about 13 tons, and the car can attain speeds of about three mph on moderate grades (up to eight percent).

The exhaust conditioning is accomplished with a scrubber. It washes the exhaust gas in a ten percent aqueous solution of sodium sulfite inhibited by the addition of 0.5 percent hydroquinone, and it effectively removes the ethelaldehyde and formaldehyde gases from the engine exhaust. The presence of these aldehydes in the exhaust is known to be responsible for the disagreeable odor, and nose and eye irritations that accompany the use of diesel engines.

Diesel cars have many advantages over cable-reel type in TCI's ore min-



A diesel front-end loader cleans up scattered ore after blasting, saving valuable loading time and aiding in the maintenance of cleaner shuttle car roadways

ing operations. The flexibility, speed, grade ability and length of haul gave the company the opportunity to modify and change mining layouts and to operate more efficiently.

When the success of diesel equipment became apparent, plans were formulated for more diesel equipment units to be used underground. It must be remembered—safety within TCI's mining operations is of prime importance, and the prevention of personal injuries must continue to be the first consideration.

The flexibility, speed, grade-ability and length of haul permitted by diesel shuttle cars gave TCI the opportunity to modify and change mining layouts and to operate more efficiently

Experience Dictates Need for Four-Wheel Steering, Traction

Operation of three diesel-electric shuttle cars in different mining conditions and in many areas of the mines enabled the company to determine what type of equipment would be needed for the future. The diesel-electric shuttle cars were two-wheel drive and two-wheel steer. Operating experience dictated a need for shuttle cars that were completely dieselized, and had four-wheel steering and four-wheel traction.

The electric cable-reel type shuttle cars were replaced, as required, with improved and completely dieselized type shuttle cars. The new diesel cars were equipped with non-chemical type exhaust gas conditioners using only clean water.

Two diesel shuttle cars from one manufacturer were placed in operation in 1957; six diesel shuttle cars of another manufacturer were placed in operation in 1958 and five additional shuttle cars were purchased in 1959. The company now has a total of three diesel-electric and 13 completely diesel shuttle cars in operation.

The completely diesel shuttle cars had to meet these basic specifications:

1. Operate on grades up to 25 percent at normal speeds up to four mph, with a speed of 1.5 mph tolerated under the heaviest grades.

2. Shuttle car engine must have a U. S. Bureau of Mines approval plate. The exhaust scrubber should have a minimum operating capacity for eight hours of operation.

3. Engine should be a four-cycle unit with indirect fuel injection.

4. The shuttle car should have four-wheel steer and four-wheel drive and the car should be able to negotiate a 90° turn in an 18-ft width without maneuvering.

5. Hauling capacity of the shuttle car should be about 230 cu ft of material.

With the increase in the number of diesel shuttle cars in operation, an intensive operator training program was embarked upon in order to attain maximum safety and efficiency. Safe practice instruction cards were prepared and used to train the operators to follow correct procedure, and operate the cars safely.

Diesel Front-End Loaders Handle Scattered Muck Problem

After several years of conventional mechanized mining followed by the introduction of the diesel-electric and diesel shuttle cars, local management was in the market to improve the productive capacity of its loading equipment. Certainly the most obvious method would be to get higher capacity loaders, but none were available. With the enthusiasm created by the diesel-electric shuttle car, the company had the proper psychological climate established to study further each phase of its mining operation. This study would lead naturally to cost improvements. Everybody was brought into the act and the concerted effort disclosed one glaring area just ripe for improvement—the machine loading rate was capable of giving eight tpm, but the company was only loading at a rate of about two tpm.

Why?

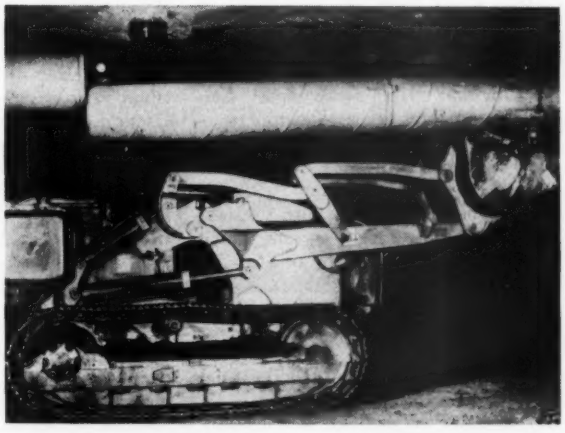
The answer was simple. The loading machine was spending a great deal of its loading time loading the loosely scattered fly rock resulting from the blasting operations. When the loading machine was in the main pile of muck, the loading rate correspondingly leaped to new heights.

The problem was to find a means to concentrate this loosely scattered fly rock and to load it more quickly.

The solution was found in a diesel front-end loader, which took care of the scattered muck problem and in addition, it is used to great advantage for service and utility work, such as cleaning roadways, giving better tire life for shuttle cars and other trackless equipment.

Two diesel front-end loaders were purchased in 1956; these proved that all of management's expectations could be fulfilled in regard to its studies concerning loading and service work.

In 1957 ten additional diesel front-end loaders were purchased, making the mines diesel equipped throughout all operating sections. Performances were in accordance with all expectations.



Diesel front-end loaders have proven their versatility in service work. Serious consideration will be given by TCI to dieselizing new mines to a greater degree. Even more equipment such as locomotives, drill jumbos, service equipment and, of course, shuttle cars will be diesel powered

Below are the readings taken on diesel equipment underground over a one-week's period in 1961.

EQUIPMENT	LOCATION	%CO	%CO_2	%O_2	NO_2 (ppm)	REMARKS
3 Shuttle Cars & 1 FE Ldr.	14 Panel #7 Mine	0.00	0.00	20.6	0.00	In return air course
1 Shuttle Car & 1 FE Ldr.	So. Hlg. #7 Mine	0.00	0.00	20.6	0.00	"
1 FE Ldr.	20 Panel #7 Mine	0.00	0.00	20.6	0.00	"
2 Shuttle Cars & 1 FE Ldr.	35 Panel #8 Mine	0.00	0.00	20.6	0.00	"
2 Shuttle Cars & 1 FE Ldr.	SE Hlg. #8 Mine	0.00	0.00	20.6	0.00	"
2 Shuttle Cars & 1 FE Ldr.	132 Panel #11 Mine	0.00	0.00	20.7	0.00	"
2 Shuttle Cars	123 Panel #11 Mine	0.00	0.00	20.6	0.00	"
2 Shuttle Cars & 1 FE Ldr.	119 Panel #11 Mine	0.00	0.00	20.6	0.00	"

Exhaust gases on the diesel equipment were well within the required limits and oxygen content above standard requirements.

Allowable Concentration	%CO	%CO_2	NO_2 (ppm)	REMARKS
Oxygen content to be not less than 20 percent.	0.01	0.50	25	Gases in general atmosphere after scrubber.

The ventilation department regularly checks all diesel engines and reports its findings. Part of a typical report sent to the chief engineer by the ventilation engineer on "Exhaust Gas Analysis-Diesel Equipment Underground" is shown. Copies are sent to the general superintendent, operating superintendent, chief mine inspector, maintenance superintendent and the State of Alabama. Samples are taken monthly—more often if conditions indicate the need. Tests of the exhaust gas, after scrubbing, for carbon monoxide are made weekly

Diesel power underground was increasing in importance and a wider variety of equipment and shuttle cars was becoming available from the equipment manufacturers.

Dirt Cause of Most Engine Wear

Maintenance of diesel equipment is most important in order to insure a trouble-free flow of ore from the loader to the tram car.

Diesel engine maintenance, properly executed, can mean increased equipment availability, lower operating costs, and better performance.

Dirt is the cause of most wear in an engine; much of it is composed of gritty mineral particles, which are hard enough to penetrate the toughest oil film and grind away metal. Cylinders, piston walls, and piston rings suffer most from dirty intake air. They wear hundreds of times faster with dirty intake air than with air filtered by an effective air cleaner.

A worn-out engine is one which has had only an ounce or so of metal worn away from critical bearing or sealing surfaces. Replacements of worn parts and the time lost may cost hundreds of dollars; dollars which could have been saved by keeping out the dirt.

Moral: Be sure the air filter is effective.

Fuel must be the type that will burn readily and completely within the engine. TCI uses Diesel No. 1 fuel. Fuel must be injected as a fine spray and mixed with clean air to burn. The penalties for violations of these requirements are the same as for using poor grade fuel. Proper fuel combustion depends upon adequate air supply as well as adequate fuel supply. When air supply is restricted, the engine will lose horsepower, the exhaust will be smoky, and some of the unburned fuel will get by the piston rings and dilute the lubricating oil.

Lubricating oil performs four functions in a diesel engine: it reduces friction, it scavenges by picking up carbon and other small particles, it cools pistons, liners, and bearings and completes the seal of rings to pistons and cylinder walls. Lubrication failures can be costly. Down time and overhaul expense for one engine failure may cost as much as does 1000 oil changes.

Engines must not be operated beyond the maximum rated rpm for which they were designed. Over-speeding often causes pistons to strike and break valves, and injectors to stick. When a shuttle car, going down grade, pushes the engine above the governed speed, the governor shuts off all fuel to the injectors and deprives the injectors of lubrication.

Preventive Maintenance—Adhere to Well Planned Schedule

The diesel engine is constantly giving signs of its condition for the operator or the maintenance man to interpret. In many cases, the equipment operator is the first to detect signs of trouble. Unless he reports these conditions to the maintenance department, the faulty conditions may be missed until real trouble develops. It never pays to run an engine until it fails, because one part failure usually ruins other good parts.

Preventive maintenance is simply a series of checking, replacement, and repair operations intended to forestall progressive damage to equipment.

Delaying a maintenance job that needs to be done is a reckless gamble. There are very few engine failures which are not preceded by warning signals and signs that can be detected by a good maintenance mechanic.

The objective of preventive maintenance is to correct unfavorable conditions that develop during engine use before they get serious enough to cause damage. The value of the program is dependent upon meeting proper time requirements by adhering to a well planned schedule.

Preventive maintenance performed on schedule is the easiest as well as the least expensive type of maintenance. It requires less work and material to prevent failures than to remedy them.

Paper Work Necessary to Control Maintenance Program

Maintenance must not be relegated to a role of secondary importance for the sake of a temporary increase in production.

A small amount of paper work is necessary to control this program. Check sheets are needed to detail the jobs to be done and to make a record of what is to be done. Summary work orders, listing labor and material, are important to control cost.

It is important to remember that paper work is useful only as it reduces the work load instead of contributing to it.

Paper work needs to be as simple as possible to maintain its effectiveness.

Weekly analyses are made of the atmosphere around each piece of

diesel equipment in order to know and control carbon monoxide, oxygen, carbon dioxide, oxide of nitrogen, and aldehydes percentages.

If there is any indication that the amounts of gas or fumes are approaching the lower limits of permissibility, that particular piece of equipment is removed from operation and corrected.

All diesel engines are shut off if there is any interruption of underground ventilation for any reason.

Advantages Include Increased Safety

It is difficult to measure all of the benefits that TCI has derived from the use of diesel equipment in its underground mining operations, but they are a major factor in obtaining increased tonnages at a lower cost with increased safety in the ore mines. The increased flexibility of shuttle car operation has enabled management to change mining layouts wherein less service work for the operation would be required.

The problem of applying and integrating diesel equipment into all of the company's mining operations will provide a greater field for the application of production engineering to the improvements of mining methods and costs of the future.

Where previously restricted to shuttle car haulage distances of about 400 ft because of trailing cables, management now has plans contemplating shuttle car haulage distances up to 2500 ft. The trailing cables were also restrictive to the movements of other equipment in operating areas, presenting numerous related hazards. Diesel equipment requires more day to day maintenance when compared with electric cable-reel equipment; however, after the operators and maintenance personnel are properly trained, the labor and material cost effects are not abnormal.

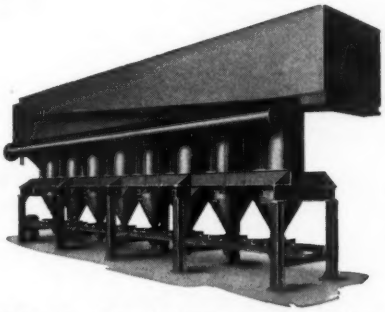
Use of diesel powered equipment in TCI's underground mines has reduced the hazards as compared with trailing cable equipment. Its safety records show accidents caused by trailing cables, including tripping, flipping rocks and other objects, electrical shock, fires, and several other types of injury. Trailing cables are always subjected to abuse from sudden strain, and from being run over, resulting in failures which cause delays and replacements.

The fumes of diesel equipment due to faulty scrubber maintenance are self-policing in themselves because they are readily detected.

Dieselization is changing the company's mining picture rather dramatically. Proper recognition must be given to the problems of diesel equipment and management finds the advantages far outweigh the disadvantages. These advantages bear repeating: flexibility in movement throughout a mining area, longer length haul due to no cable restriction, speed of travel, grade ability, and safety of operation.

TCI has been willing to try new and unfamiliar techniques and equipment in a continuing effort to increase the safety of its mining operation and further reduce the cost of mining. Serious consideration will be given for future new mines to become dieselized to a greater degree where equipment such as locomotives, drill jumbos, service equipment and of course shuttle cars will be diesel powered.

There is no doubt that continued study and engineering will develop even better diesel mining equipment and mining methods than are in use today. The use of diesel equipment will continue to increase because of its mobility, efficiency, and safety in operations.



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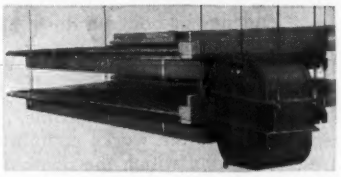

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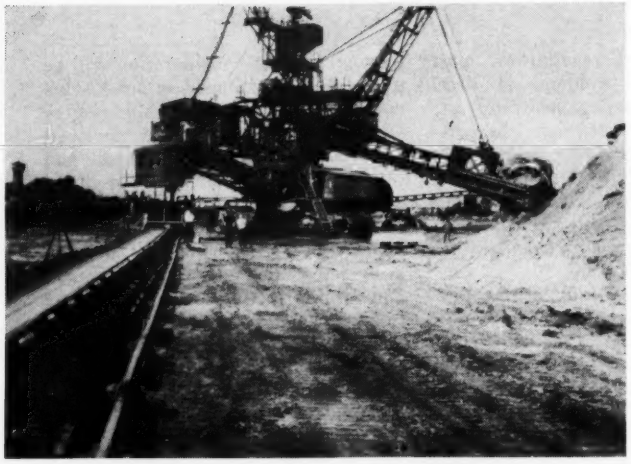


This German machine deposits excavated material on a conveyor belt. German operations usually involve deeper workings, thicker coal seams and wider pit openings than in this country which means that stripping by overcasting generally is not feasible

Application and Performance of Wheel Excavators

Wheel excavators see different types of service in Europe than in this country

By HENRY RUMFELT
Application Engineer
Bucyrus-Erie Co.

THERE are two types of wheel excavators of interest to the strip miner, especially the coal miner. One is the large type developed primarily for the brown coal industry in Germany; the other is the type developed mostly in the coal strip mines of Fulton County, Ill., usually referred to as the Kolbe wheel excavator.

While both machines are called wheel excavators, they differ considerably in mechanical construction as well as in their application. In some respects, however, they are similar. For example, both are electrically powered, and a digging wheel and an internal belt conveyor system are common to both.

The domestic machines are used exclusively in overburden excavation whereas the German machines may be used in either overburden removal or in coal reclamation. Of even greater significance is the thinking behind the application of each. In other words, the philosophy of application of each one varies considerably from the other.

Two Types Differ Considerably in Mechanical Construction

German machine. The German type wheel excavator usually is crawler-mounted with the mountings arranged so as to give three-point support. Crawler units may be grouped in various ways but they are almost universally arranged around the three-point support system. The machines are designed with very low ground to machine bearing pressures, which are usually kept to between 16 and 19 psi. Thus the machines are made capable of operating on bench surfaces in the overburden where the supporting soil strength is quite low without tendency of bogging down and therefore without need for mats. It is reported the travel gear may account for as much as 30 percent of the entire weight of the machine.

The lower works contain a roller race upon which the revolving frame swings. Normally the revolving frame can swing freely in complete circles, providing collector rings are used to transmit the electric current from cables through the base to the machinery on the revolving frame.

The digging boom (or ladder as we would refer to it in the United States) may be pin connected to the revolving frame so that the outer end can be freely lowered and raised while digging. On the outer extremity the wheel and its drive machinery are mounted. It is reported that most of the recent designs do not embody the crowd in and out feature on the digging boom, partially because it causes a large center of gravity shift in the revolving frame. Furthermore, it is said that with proper powering arrangement on the crawlers, and with proper use, the crowd-less machines can keep the conveyor belts more consistently loaded than can the other. The digging wheel may be either the cell type or the cell-less type depending upon details of the application.

The digging boom is usually independently counterweighted. While the stacker boom is mounted on the revolving frame, but in such a way as to permit limited independent slewing; it too is usually separately counterweighted. Each boom, of course, is equipped with its own conveyor belt. The transfer of material between booms is made complicated by the variable horizontal angles of transfer. One popular method effects the change at the common centers of rotation. The outer edge of the discharge boom can be lowered and raised to a slight extent as well as being moved about 120° in a horizontal plane. The extent of the raising and lowering, however, seems to have little influence upon the usefulness of the machine as it is usually applied. The discharge material ordinarily feeds into a haulage medium such as a conveyor system or a train of rail cars.

To give an idea of the spread in sizes, but without attempting to define the top and bottom limits, it can be stated that one of the smaller machines has a service weight of about 55 short tons. It has a theoreti-

cal output of 260 cu yd per hr, and the range of the digging boom elevation is from 20 ft above to 2.5 ft below track level. One of the more rangey, larger machines has an operating weight of 5500 short tons, a theoretical output of 13,000 cu yd per hr, and a digging range from 165 ft above to 65 ft below track level.

U. S. machine. The type of machine developed in the United States also has a wheel digging device and an internal conveyor belt system. All existing U. S. wheels are mounted on stripping shovel bases with four corner support and under each support is a twin belted crawler frame. The corners are supported on hydraulic jacks for leveling purposes and for equalizing loads when traveling over uneven surfaces. When set for digging, the hydraulic cylinders are fixed and the track pads are required to transmit changing loads through their bearing surfaces due to the shifting center of gravity caused mainly by the crowding in and out of the heavy digging ladder. Average bearing pressures are in the vicinity of 45 psi or even higher since the machines in production operate only from the coal surface. Stripping shovels set the pattern for this loading because through them these loads are found to be tolerable on the surface from which they normally operate, which is also a coal surface in most cases.

There is no counterweighting of the digging ladder nor of the stacker boom because the horizontal angular relationship does not change. As a result they are mounted on the same revolving frame and one helps counterbalance the other. Since the transfer of material takes place within a vertical plane it does not require a relatively intricate design. The superstructure and ladder are designed to permit digging through a prescribed vertical range and through a prescribed distance out from the centerline of the machine. The superstructure and stacker are proportioned to provide sufficient reach for disposing of the specified overburden well back on the shovel spoils.

The up-cutting wheel is favored. It digs the material loose from the bank and through a transfer device moves it over to the ladder conveyor belt. The up-cutter wheels are universally the "plug" or "cell-less" type.

Much research and cut and trial experience have gone into the most recent designs of the digging wheel, its bucket, and other appurtenances. The result is a device that will handle quite satisfactorily the variety of materials encountered, especially those of the type found in Fulton County, Ill. There the material grades from sticky clays, containing some floating boulders, into shales of varying degrees of hardness and of varying composition. To further complicate the digging problem, several inches of frost are not uncommon in winter operations. Thus, the "diggability" and ability to move those obstinate materials on a belt assume major significances in the U. S. machines.

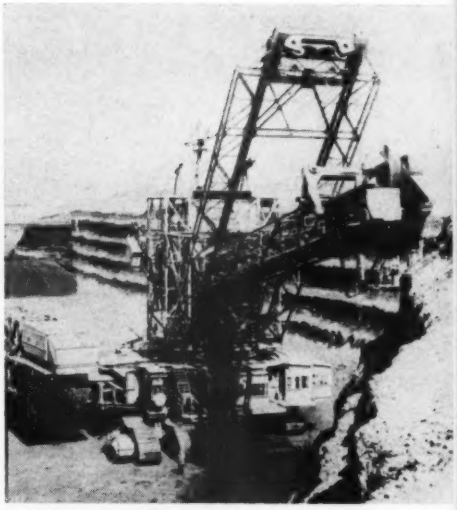
On the other hand, such problems seem to be of little concern for the German machines. It is understood that the overburden material in their brown coal belts is quite uniform. It consists mostly of sands or other friable material that will flow quite easily with comparatively little digging effort.

German Machines Dig Overburden or Coal

The German type application usually concerns a bank of overburden and a thick seam of brown coal. The wheel excavator may be required to dig the overburden or the coal and frequently the machines are rated in terms of theoretical production rates of either.

In overburden removal the wheel excavator is usually positioned for the most efficient maneuvers obtainable for the work to be done. In one method, for example, the wheel digs material ahead in a wide strip from the ground surface to the coal surface or down to the surface on which the excavator stands. The crowding action may be provided by a boom equipped with in and out thrust, or it may be accomplished through the propel machinery. Although it is expected that the one without crowd is becoming more favored, it is understood each type has its own advantages and disadvantages.

As the machine progresses along the cut, instead of spoiling by direct overcasting, it deposits the material into some transporting medium, such as a conveyor or rail system, which moves the material from the digging wheel to the dump where the material is usually placed in its final resting place. Delays involved in the orthodox procedure of the acceptable haulage systems are evidently being currently studied with the idea of reducing them where practicable. This kind of improvement enhances the desirability of large expensive machines, such as the huge excavators and stackers as well as the transport systems themselves. Thus the economics of this application becomes more attractive in situations where the other pertinent factors are favorable.



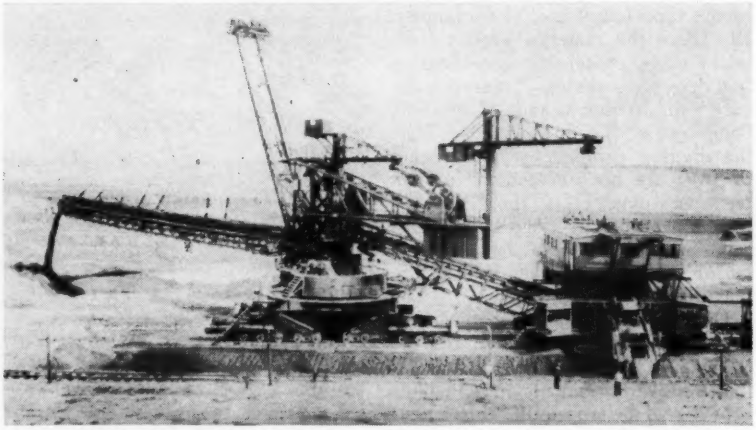
Another application of the German wheel. In this case, it loads into rail cars through an intermediate device. If the overburden is hauled long distances, rail haulage is generally used. If the haul is short, conveyors are used

The spoil area may be a nearby worked out pit or it may be on the opposite side of the same pit being worked if the area and plan development are extensive enough to permit the required working benches and the required spoil slopes.

In some isolated instances it is understood that the plan development may be such that the spoil could be overcast. The pile would be constructed so that the toe would be close to the pay rib in a manner remindful of the popular domestic practice.

However, from the evidence obtained it is indicated that most of the actual cases involve the transporting of the overburden as a separate function. The transportation may be efficiently organized rail haulage, it may be an ingenious system of shiftable belt conveyors, or it may be a combination of both. It is understood that exceptionally long hauls generally favor the rail and the shorter ones the conveyors.

Since the transportation function is divorced from the excavator, the depth and width of cut obtainable with one haulage way setting become significant in measuring the value of an excavator. A machine which could excavate all the material from 165 ft above to 65 ft below the operating level and load it out on one haulage way setting would achieve a comparatively high efficiency for a given quantity of excavation. Another machine that could excavate



A stacking machine. Spoil is dumped from railroad cars into a transfer ditch from which the stacker picks it up and conveys it to the spoil pile via the long stacker boom

less over-all depths would work at a proportionately less efficiency for the same quantity of excavation.

The use of extension devices working between the haulage way and the excavator discharge boom makes possible wider cuts than otherwise. This is an example of further refinement evidently aimed at increasing the over-all efficiency through extending the usefulness of one haulage way setting.

German engineers have derived an index which is considered as a measure of machine usefulness. The translation is termed "economy efficiency". The equation is:

$$E = \frac{\text{Service Weight}}{Q \times H} = \text{Kg/M}^4 \text{ or Lb/yd}^4$$

where E = The "economy efficiency"
Q = Output in cubic meters or in cubic yards
H = Cutting height in meters or in yards, and the Service Weight would be in kilograms or pounds

In order to negotiate a depth of 328 ft, it has been shown that an excavator equipped with a conventional digging boom belt conveyor system would have proportions giving an economic efficiency of 13.9 lb/yd.[4] Also it has been demonstrated that through the use of exceptionally steep conveyors, made possible by a cover belt, the same depth and the same production on the same haulage way setting could be obtained with a machine of only 11.6 lb/yd[4] economy efficiency. This kind of advantage seems to have stimulated the endeavor to perfect the steep conveyor. Conveyor slopes have been increased from the orthodox 18° up to 36°. The cover belt application is admittedly restricted but where applicable the advantage is significant.

The same theme of efficiency improvement follows through to the discharge end of the transportation system. Stackers have been designed so that spoil piles can be constructed below a given operating floor and above the same floor obviously so as to maximize the utilization of the haulage way once it is laid into the spoil area.

Domestic Units Must Be Employed in Tandem Operation

All domestic wheel excavators are so designed that they must be employed in a tandem operation. At present each one is working with a stripping shovel. The pit development and cut widths follow the orthodox pattern of prairie type shovel stripping procedures. To allow the shovel and wheel excavator to pass at will, pit widths are about 110 ft, somewhat wider than would be the case for a shovel alone.

The wheel excavator precedes the shovel and takes the top portion of the cut, leaving the lower for the shovel. The shovel digs the lower part which is usually blasted consolidated material, and builds a spoil pile immediately adjacent to the coal rib. Later, when taking the top of the succeeding cut, the wheel places its spoil well back in heaps which resemble in plan a series of overlapping crescent shaped designs. The material consists mostly of the unconsolidated surface materials together with possibly some small shale particles. This arrangement of the separately placed spoils provides a significant advantage in that it tends to stabilize the slopes and to protect the pit from spoil slides. Also, the bench on the high wall provides a shelf to contain ravelings or sloughings from the top high wall and thus helps to stabilize that slope.

It becomes apparent the domestic stripping wheel excavator digs out the material and transports it from the point of removal to its place in the spoil pile where it remains permanently from the mining viewpoint. Although it operates in tandem with the shovel, the material it digs is handled only once.

The usefulness of the stripping wheel excavator is dependent upon the production rate of the stripping shovel with which it works. Actually each is dependent upon the other and the optimal arrangement involves practically balanced production rates and complementary operating ranges of the two tandem working machines.

Material Must Be Economically "Diggable"

While the observations and reported findings are pertinent to their specific activities, they seem to fall into no particular pattern that would give the basis for general conclusions, nor do they point to precise guidance for other seemingly similar prospective uses.

There are other activities underway or activities that have been previously undertaken by other kinds of wheel excavators. Some of these include truck loading, trenching, stockpile reclaiming, short range overcasting and probably many others unknown to the writer. Off hand, their potential would seem to be limited to specialized areas within their general spheres but their analysis is beyond the scope of this article.

The philosophy behind the German open pit whel excavator operation and that behind the domestic stripping operations where wheel excavators are used are quite different. The German procedure, despite comparatively favorable overburden to coal ratios, usually involves deeper workings, thicker coal seams, and wider pit openings which means that stripping by simple overcasting generally is not feasible. However, the overburden material seems to be quite consistent and of the type that is almost ideal for the digging device and conveying system of a wheel excavator. Transport for the purpose of hauling the material away is pre-supposed. Their indicated trend is toward wider and faster moving belts, and improved operating efficiencies with rangey excavators of relatively more advantageous "economy efficiency".

The domestic practice usually involves larger overburden to coal ratios and the objective is to operate the pits to lesser depths, to reclaim relatively thin coal seams under an overburden of more varied and more difficult digging characteristics. Very

This U. S. machine digs the top portion of the cut and transports the material to its resting place in the spoil bank. Shovel spoil forms a dam for the less stable wheel spoil and the bench cut in the highwall forms a safety shelf to contain ravelings from top highwall

low unit stripping costs are essential; therefore, efforts are concentrated on digging the overburden and putting it away in one simple operation, if possible. Larger capacity single units are preferred but in cases where other such factors as slope stability become a criterion, then tandem operations involving the Kolbe type wheel become attractive possibilities. To determine the economic possibilities of any newly proposed application, in the writer's opinion, requires the evaluation of every pertinent facet of the work in an imaginary model of the proposed operation. The true value of the appraisal would depend upon the accuracy in determining these pertinent facets and the quality of their evaluations. One prime consideration, however, which seems almost self evident concerns the nature of the material. It must be economically "diggable" and once dug it must be efficiently and economically transportable on a conveyor system for whatever distance required.

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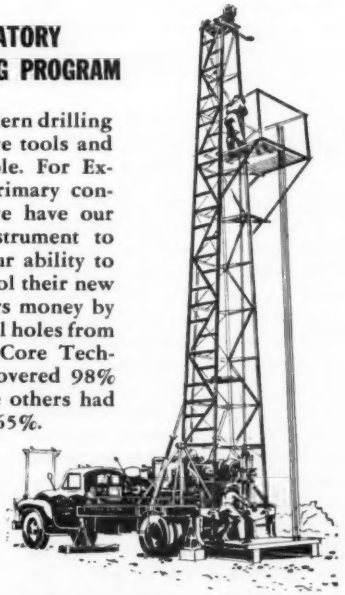

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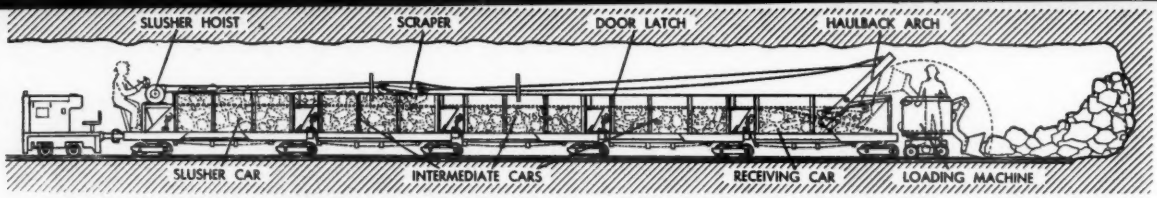


Fig. 1. A train-loading unit receives ore continuously from the mucking machine. At the Britannia mine, the unit consists of six cars which handle a six ft break. As ore is mucked into the receiving car, the slusher operator first fills the slusher car retreating progressively toward the mucker

NEW DRIFTING METHOD at Britannia Mine

By D. W. PRINGLE
Manager
and
H. W. SHUTTLEWORTH
Mine Superintendent
Britannia Mine
Howe Sound Co.

By careful planning and use of readily available equipment Britannia mine was able to drive a mile-long drift on a tight time schedule and at reasonable cost

THE Britannia mine of Howe Sound Co. is situated at Britannia Beach on Howe Sound about 30 miles north of Vancouver, B. C. The mine has been in production almost continuously for approximately 50 years, but in 1958 the whole plant closed down for ten months due to low metal prices.

The mine reopened January 1, 1959 on a reduced scale, milling 1400 tpd on a 44-hour per week basis. Daily tonnage milled dropped from 6000 tpd in 1938, to 3000 tpd through 1946–1957, to the present 1400 tpd.

Ore bodies of the mine are in the so-called Britannia shear zone which, on company holdings, is about seven miles in length and 1600 ft in width. The present mine workings have been limited to the footwall section of the shear zone for the most part. Vertical range of the mine workings is 6000 ft.

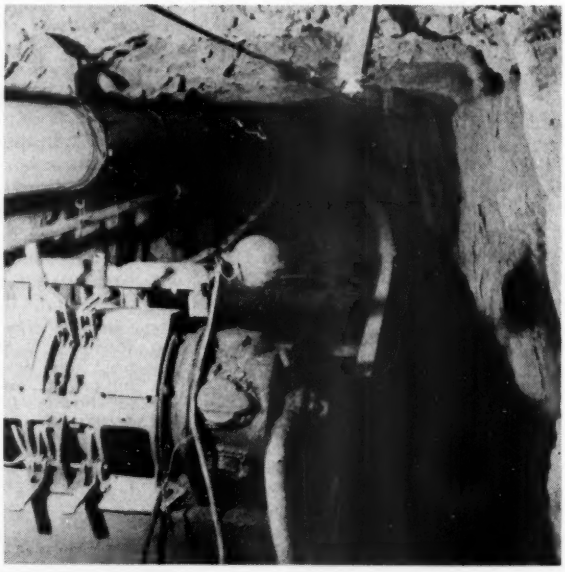
Exploration Drifting Target Was 500 Ft Per Month

When the mine was reopened in 1959, it was decided that a major exploration drift should be driven eastward for about one mile to explore the shear zone at depth. This drift was collared off the main haulage level, 20,000 ft from the portal, 4100 ft below the upper mine workings and near the eastern limit of the mine. From this drift a pattern of diamond drill holes would crosscut the shear zone on 400 ft centers. These holes would approximate 850 ft in length.

In the interest of efficiency it was important to obtain maximum drifting footage at reasonable cost. The footage target was set at 500 ft per month. In order to accomplish this with a small crew, more mechanization of equipment was required than conventional methods allowed.

As sometimes happens in cases like this, the general method was dictated by the equipment available. A Trainloader, a major item, was obtained from one of the mines in the Howe Sound group. This equipment is an articulating string of cars coupled together to suit the length of round drilled (figure 1). It is manufactured by Coeur d'Alene Co., Wallace, Idaho. For this heading six cars handle a six-ft break. Two Eimco 21 mucking machines with D decks were available as well as a six-ton trolley locomotive for servicing the heading and Trainloader.

Another major item, the drill jumbo, was designed and made up for the heading with a 5 ft by 20 ft flat deck and lift sides 12 in. wide (figure 2). The sides are divided into three pieces for ease of handling and for use on curves. Cleats for the air leg drills are ½ in. by 2 in. bars spaced at 12 in. An air and water manifold is installed on the jumbo to speed set up time. A two-gal line oiler handles



Train-loading unit viewed from slusher car which carries an air-operated slusher. Any waiting time experienced by the mucker would be eliminated through the use of an electric slusher

all lubrication. A D-99, four-in. drill mounted on a G-D 2NC10 screw feed handles the five-in. cut hole. The screw feed will drill a ten-ft hole at one pass. This allows the cut hole to be drilled while two miners are drilling the square. Gardner-Denver 600 series rods are used with a 600–1000 series adapter to handle a five-in. Timken bit on the cut machine.

Ventilation is handled by 15-in. 20-gauge galvanized pipe. Woods of Colchester 15-in. dual-duty reversible fans are spaced every 1200 ft. This system produces about 5000 cfm.

The air leg drills are Atlas Copco BBC-22W Lions with retractable legs. Alloyed drill steel is ⅞ hex of the tapered type. Bits are 1½ in. diam 12° taper design. Approximate footage per bit is 300 ft, giving a cost of two cents per foot drilled.

Available Equipment Dictated Drift Dimensions

The above equipment dictated the size of the tunnel and this was set at 8 ft by 8½ ft high. The eight ft width allowed passage alongside the Trainloader. The height was the minimum possible because of the 250-volt trolley wire.

As a point of interest diamond drill stations were cut overhead. Each cut-out consisted of one drift-width raise round and two or three rounds each way, giving a total length of 30 ft. The method allowed the drill program to stay close to the face. Long rod pulls were possible on the second hole due to exact alignment with the first hole in the cut-out. Presently all holes are of A size averaging 850 ft in length. Cost has been $3.00 per ft of hole exclusive of compressed air cost.

Various methods, crews and length of rounds have been tried since the heading was started. This article deals with the present method which is definitely the most successful here.

A three-man crew is used with one man being the lead-hand. The crew drills, blasts and mucks out. It also does all necessary servicing, such as installation of four-in. air line, two-in. water line, 15-in. ventilation pipe, track and rock bolts. Trolley wire extensions are added by the electricians.

The heading is being advanced on a three-shift basis and on an alternating five and six day week. The objective has been 500 ft per month of total heading, that is, main heading and diamond drill crosscuts. This has been obtained since May 1960, with 595 ft being advanced in July.

Table 1 is a time study of a typical cycle by the three-man crew. The lead-hand controlled the tempo of the operation mostly by coordinating all the work. He assisted in collaring almost every hole, repaired a broken drill, watched that necessary maintenance was done, such as oiling, changing bits, checking on the D99 and doing the final connecting and spitting of the round.

Advance Was 2.87 Ft Per Man-Shift

The mucking machine and scraper showed no appreciable lag in one waiting for the other. If more than six cars were used it would probably

Table 1. Time Study of Drifting Cycle in 234 Drift, 4100 Level

Operation—Drill and blast 6 ft round in 8 ft by 8½ ft heading, using 35 holes

Operation	*Start Time*	*Finish Time*	*Elapsed Time*	*Remarks*
Leave main portal	8:00	8:35	35	Travel four miles
Arrive 234 drift	8:35	8.43	8	Load Steel, bits, oil, switch 220-V motor from Trainloader to drill jumbo
Travel to face	8:43	8:52	9	Drop off diamond driller, travel 3000′
Hook up air	8:52	8:56	4	Clean face, connect jumper wire, fill lubricator
Take line and grade	8:56	8:58	2	
Collar cut hole	8:58	8:59	1	5″ hole drilled 6′ in 35 min (2″ per min). Lead-hand checks D-99
Start drilling w/jack-legs, drill 18 holes	8:59	9:38	39	Change broken water tube—one drill out 5 min. Average drill speed; 22″–24″/min
Move drill car	9:38	9:40	2	Take drills off carriage. Pins through drill car to hold ladders for leg support
Drill 16 holes	9:40	10:13	33	Lead-hand helps collar all holes, mucks back for lifters, changes bits, supplies steel, drill pipe hanger holes. Eight bits to one round
Remove gear, blow holes	10:13	10:20	7	Load drills, hook up blow pipe, blow holes, split powder
Prepare to load	10:20	10:23	3	Move up drill jumbo, bring up powder, remove headers
Load round	10:23	10:34	11	3–24″ sticks per hole. Helpers 7–4″ sticks with 8″ wood spacers. Fuse 9′ long
Wire up	10:34	10:40	6	Two cases 1¼″ × 24″. 14 sticks 1¼″ × 8″ Type A igniter cord. Move train back, check igniter cord functioning O.K.
Light up	10:40	10:42	2	
Ride out	10:42	10:48	6	Pick up driller
Change units			—	Drop jumbo, pick up Trainloader, oil hoist motor
Total drill cycle			133 minutes	(does not include 35 min of travel from portal)

Operation—Muck out six-ft round with Trainloader

Operation	*Start Time*	*Time Finish*	*Elapsed Time*	*Remarks*
Leave lunchroom, travel 3500 ft	11:25	11:33	8	Pick up 2–6″ × 10″ × 5′ ties. Push in train. Drop off driller. 220-volt line loss noticeable in back end. No bonding
Inspect	11:33	11:36	3	Hook up air lines to mucker and hoist while one man washes and starts to scale. Put mucker in gear
Clean track	11:36	11:40	4	Mucker cleans track, pushing muck ahead until train is brought up
Hoist bail	11:40	11:42	2	Raise bail for tail block. Turn on spotlight, scale down
Begin loading	11:42	12:10	28	Muck 35 tons total. Scraper waits on mucker 15% during first two cars, then both about even
Move slide rails	12:10	12:15	5	Move train ahead as muck advances. Pull motor back, put in tie, advance slide rail, put tie digger on mucking machine bucket
Continue loading	12:15	12:24	9	Lead-hand checks muck pile for sufficient storage in the front end of Trainloader
Move slide rails	12:24	12:30	6	Put in tie, move motor back from room
Continue loading	12:30	12:35	5	Clean up at face
Prepare to move out	12:35	12:38	3	Disconnect air, turn off spotlight. Move hoses clear
Ride out	12:38	12:44	6	Back at collar 234 Drift, put battery on charge
Total to muck out round			79 minutes	

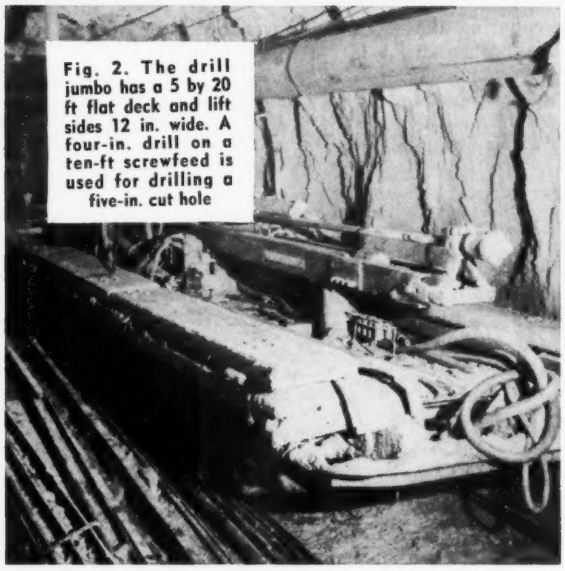
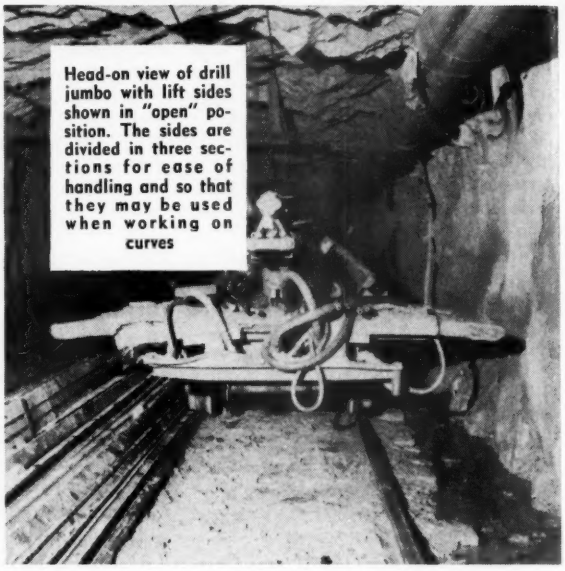


Fig. 2. The drill jumbo has a 5 by 20 ft flat deck and lift sides 12 in. wide. A four-in. drill on a ten-ft screwfeed is used for drilling a five-in. cut hole



Head-on view of drill jumbo with lift sides shown in "open" position. The sides are divided in three sections for ease of handling and so that they may be used when working on curves

show. The scraper handles two buckets of muck handily, but slows down when the operator takes three.

The spotlight is quite an assist to visibility. The trolley wire is off center and about four ft from the scraper cable, thus any small whip of the slusher cable does not contact it. For about one-third of the mucking cycle the third man is idle, but otherwise he has productive work to do. In the drilling cycle there is no waiting time for the third man.

The time study in table 1 only covers a drill and muck cycle, but there was still time left in the shift for another drill cycle.

This schedule of operation should produce, in a 23-day month, 1½ rounds per crew shift or at 100 percent efficiency three ft per man-shift. In July 1960 a total of 595 ft was advanced with 207 man-shifts, giving 2.87 ft per man-shift. A total of 103 rounds that were drilled (using six-ft steel) and blasted, gave an average advance of 5.8 ft per round.

Following is a cost breakdown for 1959 and 1960.

Cost per foot (Drift and diamond drill crosscuts combined)	1959 (Average)	1960 (6 months)
Labor	$11.38 (Miner $1.85/hr)	$ 7.70 (Miner $1.90/hr)
Bonus	2.50	5.30
Explosives	5.17	4.44
Timber	0.37	0.81
Supplies and miscellaneous	4.78	6.21
Total	$24.20	$24.46
Total Footage	3052 ft	1946 ft

To the above direct labor cost must be added approximately 20 percent or currently $1.60 per ft for insurance, Workmen's Compensation, pension, etc. It is estimated that drill steel, bits, and machine repairs cost approximately $3.00 per ft. Therefore, the complete drift with no equipment write-offs would approximate $29.06 per ft. Charges for compressed air, mechanic's time on jumbo and mucking machine maintenance, supervision and main haulage crew's time to dispose of the waste rock from the entrance of the exploration drift, are not included in the above.

If one had a little more capital to spend on the project in the interest of speed, there are definitely some modifications which could be made. The following improvements could be considered:

1. Addition of small drills mounted on the screw feed to drill the cut helpers.

2. With a better designed jumbo, six-ft feed drills could be mounted under deck to drill knee holes while the top portion was being drilled.

3. An electric slusher mounted on the Trainloader would eliminate any wait time by the mucking machine.

4. A battery locomotive for various reasons is more efficient for this type of work.

The use of the Trainloader has helped tremendously in meeting the monthly footage schedule in this heading at the cost quoted. While the five-in. cut hole machine was designed to assist in breaking a ten-ft round, it is still of great assistance in drilling and breaking the shorter round. The drill jumbo and its equipment have assisted materially in the efficiency of operation at the face. Through the use of this equipment the cost per foot obtained is much below the original estimate.

Mucking machine dumps into receiving car of train-loading unit. Note clearance between mucker bucket and haulback arch on receiving car

Island Creek Coal Co. has produced as much as 1593 tons of material per unit shift with conventional equipment

The Future of Conventional Mining Equipment

By JACK MATHESON
Chief Methods Engineer
Island Creek Coal Co.

CONVENTIONAL mining equipment has been available to the mining industry for many years. Improvement in the performance and productive capacity of this equipment has been gradual until the past few years. During these past few years, conventional equipment has been designed by the manufacturers to provide the coal industry with equipment that would compete with the present-day continuous miners.

Continuous mining machines began to be utilized to a greater extent throughout the coal industry about 1952. Since that time an ever-increasing percentage of the annual production of the coal industry has been produced by continuous miners.

The increase in the use of continuous miners can be attributed to the improvements in these machines and the need for a reduction in the operating costs.

Management must decide between conventional equipment and continuous miners when they propose to re-equip an old mine or open a new mine. This decision must be based on the analysis of many factors, and this article will stress briefly some of the major factors involved.

Tonnage Potential—Continuous Miners vs. Conventional Equipment

One of the most important factors to be considered and analyzed for comparative purposes is the potential productive capacity of the various types of equipment. In the following discussion, certain factors will be pointed out affecting the potential of conventional equipment and continuous miners. These factors will then be summarized and compared for the different types of equipment.

Conventional Equipment. With conventional equipment, tonnage potential is controlled by the following elements: roof support, cutting, drilling, shooting, loadability and haulage. Any one of the above elements can reduce the actual tonnage realized far below the projected tonnage potential. Management must provide the proper equipment and control these elements to enable the equipment to reach its tonnage potential.

At Island Creek, the decision to re-equip two of its mines with conventional equipment was made and installation was completed during the latter part of 1959. Tonnage realized from this conversion has exceeded expectations and tonnage records continue to be broken as the crews become more proficient.

Figure 1 shows that the crews were operating at an average tonnage level of *422* tons in 1959. With the installation of the new equipment, this average shows a steady increase. The averages shown are the average tons of material per unit shift for the mine and not for the individual sections.

Peak tonnages for individual sections are as follows:

Peak shift—1593 tons
Peak week—1238 tons
Peak month—1169 tons

Tons of material are referred to rather than tons of clean coal, because this was the actual tonnage loaded by the loading machines. For comparative purposes, you can use any refuse percentage and readily calculate the clean coal tonnages.

Continuous Miner. Generally, the ripper type continuous miners employ five elements to complete a cycle.

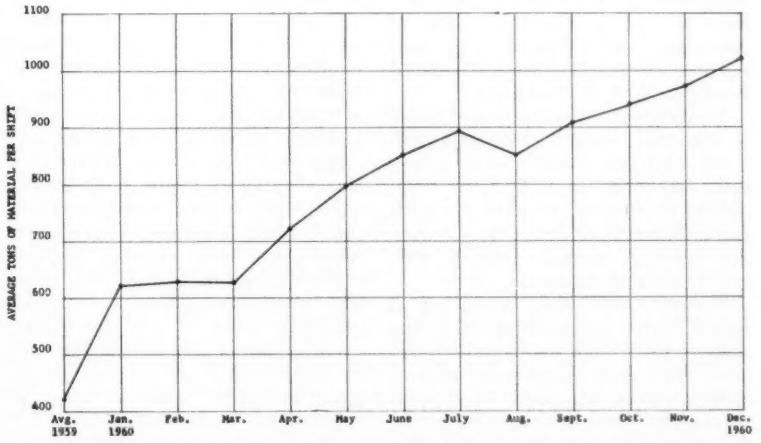


Fig. 1. Island Creek Coal Co. re-equipped two of its mines with conventional equipment, installation being completed the latter part of 1959. The chart above shows the result. Crews were producing an average of 422 tons per shift in 1959, but with the new equipment this average has steadily increased

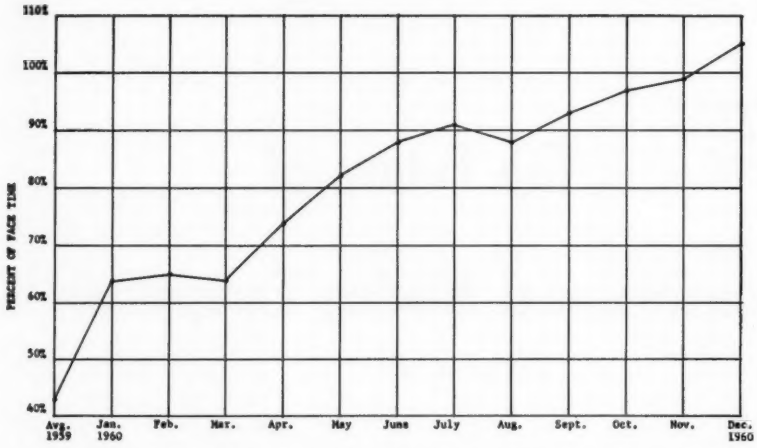


Fig. 2. Assuming that a ripper or milling type miner is operating under identical conditions with the conventional equipment used in figure 1, it would have to operate the percentage of operating shift indicated to produce the average tonnage that was realized from conventional equipment during 1960

These elements are tram, sump, raise rippers, lower rippers and position rippers. During this operation, coal is being produced by two elements only —sumping and raising or lowering the rippers. This type of miner is adaptable to seams with varying heights but as the height decreases, so does the efficiency of the machine. With the decreased height, the nonproductive operation consumes a greater percentage of the face cycle time. Constant times, regardless of the height, will be realized in all operations except the raising and lowering of the rippers.

Figure 2 shows the amount of time a ripper or milling type miner would have to be in operation to maintain the average tonnage realized from the conventional equipment.

Assuming that the ripper type miner is operating under identical conditions with the conventional equipment shown in figure 1, it would have to operate the percentage of operating shift indicated to produce the average tonnage that was realized from conventional equipment.

Assuming that the borer type miner is operating under identical conditions with the conventional equipment shown in figure 1, figure 3 indicates the feet of advance per shift for a borer type miner to produce the average tonnage realized with conventional equipment.

Summary Analysis. Experience at Island Creek has indicated that the success of a continuous miner depends, to a great extent, on roof conditions. When the roof is of such nature that it requires support before the miner has advanced a breakthrough length, the tonnage potential of the continuous miner is sharply reduced.

In addition to the time consumed by tramming, a miner also encounters a delay caused by the pick-up loader operating behind the miner. It is necessary for the loader to load all of the coal behind the miner before it can be trammed to the next place to be mined, thereby detaining the miner until this cleanup is completed.

The poor cleanup realized from many of the miners available today requires a clean-up loader as a necessary part of the miner section. However, this loader does allow the miner to mine coal during the shuttle car change, which is an advantage.

Consideration must be given to breakdowns. Any delay to the pick-up loader or continuous miner brings production to an immediate stop. Two operations are involved in producing coal on a continuous miner section. Any delay to either of these operations will result in a loss of production.

Comparing a continuous miner section with a section of conventional equipment, five operations are normally necessary to produce coal on a conventional equipment section. Generally speaking, with conventional equipment, either roof bolting, cutting, drilling or shooting will become a bottleneck to maximum potential of the loading machine. Theoretically, when a delay is incurred by the loading machine, all of this time is not lost production. Since a bottleneck probably exists in the preparation cycle, a percentage of the shift will be lost waiting on coal to be prepared and if the loader is down, the preparation cycle continues to prepare coal. This ability to prepare coal while the loader is down is a feature which is not available with a continuous miner section.

Tons Per Payroll Man Must Be Used to Compute Mining Cost

In order to justify the capital expenditure necessary to re-equip an operating mine, management must be able to show a reduction in cost as a result of making the investment. Savings can be realized in one of two ways—producing more coal with the same number of men or producing the same amount of coal with fewer men.

Generally speaking, when conventional equipment replaces conventional equipment, more tonnage per unit shift must be produced in order to realize a cost reduction. Where continuous miners replace conventional equipment, a continuation of production at the same level will result in a reduction of cost due to fewer face men.

When continuous miners first made their appearance in the coal fields, a large percentage of the total production was being produced by track sections. Two, and sometimes three, face crews for continuous miners were made from one track face crew. This resulted in a substantial cost savings.

Reduction in face crews by converting from conventional off-track equipment to continuous miners is shown in the following comparison:

	Continuous Miner	*Conventional Equipment*
Miner operator	1	0
Loader operator	1	1
Shuttle car operator	2	2
Elevator operator	1	1
Roof bolter	1	1
Cutter operator	0	1
Cutter helper	0	1
Drill operator	0	1
Shot fireman	0	1
Total	6	9

This comparison shows a savings of three face men per unit shift. With three less men, the average tons per face man for the continuous miner sections will probably be higher than that of the conventional section in the thicker seams, even with less tonnage per unit. One factor must be stressed at this point—it takes tons per payroll man, and not tons per face man, to realize a labor cost that will be competitive in the coal industry today. Basically, labor cost can be grouped into the following categories: face, general inside, preparation plant, maintenance and supervision. In order to produce desired tonnage on a reduced tons-per-unit basis, more units must be added. This increases the general inside force, supervision and maintenance requirements. The true labor cost then does

not reflect the same savings as the face labor cost and the true labor cost must be used to indicate savings.

Continuous Miners Do Better on Retreat Work

The amount of development or retreat mining remaining is another factor which must be considered by management before selecting any type of equipment.

Island Creek has found that with continuous miners, a 20 to 25 percent increase in tonnage potential is possible when working pillars as compared with development work. This experience is confirmed by a number of other coal companies which are operating similar machines.

With conventional equipment working pillars, Island Creek experiences a drop in tonnage ranging from 10 to 15 percent. This drop is generally caused by the following factors: short cuts caused by excessive weight on pillars, excessive trams due to maintaining a pillar line and an increase in roof support problems.

While a continuous miner can usually work one pillar until it is completely extracted, a conventional unit requires a minimum of three pillars to work efficiently. Small barrier pillars can be mined more readily with continuous miners than with conventional equipment. It only requires two working places for a continuous miner to operate efficiently while a minimum of four to five working places are required for a conventional section.

It is evident that when a mine is fully developed, the advantages are in favor of the continuous miner with other conditions being favorable, but when the mine is being developed, the advantages are generally found to be in favor of conventional equipment. It would be a rare mine in which a continuous miner could not be utilized effectively.

Physical Conditions of Major Importance

Seam conditions are of major importance and must be studied thoroughly. Variation in seam heights at Island Creek's mines rules out any of the boring type continuous miners that are now available. With the borer type miners not being considered, the selection of equipment must be made between ripper and milling type miners and conventional equipment. Ripper and milling type miners can be adapted to the variation in the seam heights showing an increased efficiency as the height increases, providing that the increase

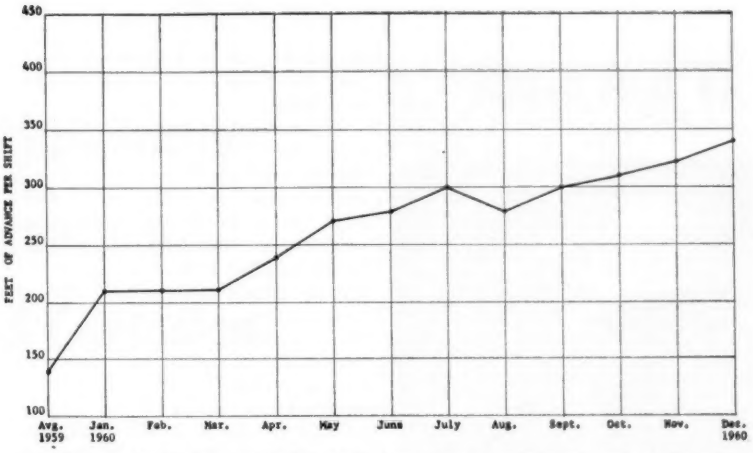


Fig. 3. Feet of advance per shift for a borer type miner to produce the average tonnage realized with conventional equipment (see figure 1) during 1960

in height does not come from rock partings. Miners can be forced through areas with heavy rock partings if management can allow for the reduction in tonnage and the prohibitive bit cost.

Considerable variation in the seam will generally necessitate working several scattered locations simultaneously in order to balance the raw feed to the preparation plant. This raw feed balance is necessary to maintain a semblance of clean coal output from month to month. Concentrating all section locations in an area with thick parting will result in a lower yield of clean coal per sectional shift and increase cost per ton. In addition to the adverse effect on cost, an increase in delay time and maintenance cost can be expected when operating under these conditions.

Continuous miner manufacturers have improved the efficiency of their miners when operating on soft bottom, however, this factor cannot be dismissed by management. In order to maintain proper ventilation on the working sections, cross-cuts or breakthroughs are necessary. Turning a breakthrough with a continuous miner on soft bottom is one of the most inefficient operations that can be found on any section.

Another factor which governs the tonnage realized from the section is roof conditions. Maximum efficiency can be realized from a continuous miner if the roof conditions will permit advancing a full breakthrough length before moving to the next place to be worked. Roof that requires support after ten or 13 ft of advance by the miner curtails the tonnage potential of a continuous miner sharply. It is accepted that continuous miners have a rate of tram speed approaching that of conventional loaders, but to realize this speed throughout the distance to be trammed is unlikely. Size of the machines to be maneuvered through breakthroughs and the amount of time consumed in cable handling shows all the advantages in favor of the conventional loader.

Conventional Equipment Favored for Domestic Market

Anticipated markets to be serviced by the mine is another factor which management must consider. With the gradual reduction of the domestic market over the past years, there is still a substantial tonnage passing through various retail yards. Since the domestic market is a high realization market, it is felt by many companies that it is worth exploiting as long as it exists. Here again, the selection favors conventional equipment due to its ability to produce a greater percentage of grade sizes. In the event that this market diminishes, the coal can be crushed at the preparation plant to the desired sizes after the coal has been processed.

Aside from the fact that a coarse product is desirable where domestic coals are in significant demand, a coarse raw product offers other advantages. For coals going to other markets, a coarse raw product is especially desirable if the ash content of the raw coal is such that separate cleaning of the fine and coarse coal with thermal drying of the fine coal is necessary. It has been found that coarse coal cleaning capacity can be purchased at a much lower capital cost than fine coal cleaning capacity. Also, it is an established fact that the coarse coal cleaning plant can be operated at a lower cost than the fine coal cleaning plant. This indicates that, under the conditions described above, continuous miners can be ex-

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pected to add to both capital costs and operating costs of the preparation plant.

With an existing preparation plant, only part of the processing difficulty can be attributed to the increase in smaller size coal. Of equal importance, and a factor that is sometimes overlooked, is the dust problem which is encountered at the face when continuous miners are used. To alleviate this problem, a spray system is employed at the face which dampens the coal and increases the fine coal screening problem. If the fine coal is removed dry ahead of the washing unit, there will be a substantial ride-over, which means more fines in the water circuit, more water clarification problems and more fine coal moisture problems.

Island Creek Re-equips Five Mines

Recently, Island Creek was faced with making a selection between conventional equipment and continuous miners when it was decided to re-equip five mines. Each of these mines was analyzed separately to insure a complete study on an individual basis.

Based on a concentrated study of available equipment and the company's previous experience with continuous miners and conventional equipment in these seams of coal and similar conditions, it was decided that conventional equipment would yield the lowest operating costs. After reaching this conclusion, all efforts were concentrated on conventional equipment for tonnage potential and cost reduction.

Visits were made to a number of operations working seams with conditions comparable to those mines under consideration. During these visits, management observed the latest conventional equipment in operation and these observations were compared to its own experience under similar conditions.

The analysis indicated that continuous miners in the thicker seams would probably produce a tons-per-man at the face equal to, or higher than, that of the conventional equipment, but the total sectional tonnage would be less. The analysis of the thinner seams indicated that the continuous miner would probably produce a tons-per-man at the face lower than that of the conventional equipment. Therefore, in both cases, in order to produce the desired total daily tonnage, extra sections of equipment would be necessary.

These extra sections of equipment would add substantially to capital costs. Further capital money outlays were projected due to the necessity for providing changeout spares for a greater number of productive machines, plus a substantial increase in money tied up in inventory items to supply the extra equipment.

Disadvantages of high capital costs, preparation plant problems and lack of flexibility to cope with the variety of prevailing seam conditions with which the mines would have to contend, offset the advantages offered by continuous miners. Based on the above data and previous experience, the indicated decision favored all conventional equipment.

The equipment per section consisted of a crawler-mounted loader with an 18 tpm peak loading rate, serviced by two large-capacity shuttle cars, a rubber-tired Universal cutter equipped with an 11-ft bar and an automatic bug duster, a self-propelled hydraulic-powered coal drill, a hydraulic-powered, self-propelled roof bolt drill, a custom-designed elevator and a hydraulic-powered car spotter.

All equipment is 440 volt a-c powered. A 300-kva transformer services the sectional equipment through two safety circuit centers, one near the loading point, having five outlets and providing taps for the car spotter, elevator, two shuttle cars and a spare. A second safety circuit center near the face services the loader, cutter roof bolt drill and the coal drill.

Island Creek is confident that it has made the best selection for its particular conditions. The experience realized from re-equipping with conventional equipment during 1960 has exceeded both the cost and production projections established to justify the required expenditures. Management is confident that as the crews become even more proficient, the re-equipped mines will operate at a cost below that of the original forecast.

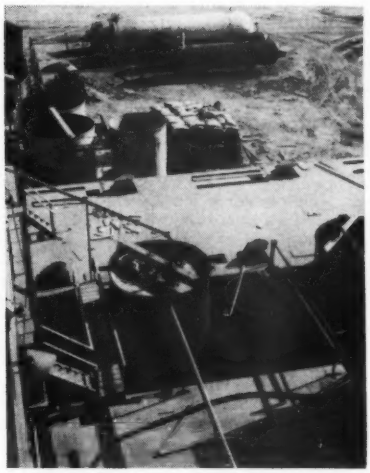
What is the future of conventional equipment? The author is convinced that the future is excellent, and is probably expanding. This does not mean that continuous miners do not have a place in the industry and will be replaced. Continuous miners do have a definite application and when manufacturers provide continuous haulage to complete the job, the use of miners will probably surge again.

The increasing capacities being built into all sectional equipment by the various manufacturers, and the flexibility realized from conventional equipment makes the future potential almost unbelievable and conventional equipment must be given careful consideration in the future.

Plastics in Metallurgy for Resistance to Abrasion and Corrosion

By MAYER B. GOREN
Chief Research Chemist
Kerr-McGee Oil Industries, Inc.

Methods and processes that were not technically feasible a few years ago have been made possible with the advent of modern plastics



Vanadium solvent extraction circuit at the Shiprock mill during construction. At the top of the picture are ammonia and sulfur dioxide storage tanks, and three tanks now used for the SO_2 reduction system that are lined with fiber glass polyester. In the center is the concrete vanadium solvent extraction circuit which is also protected with fiber glass polyester

VALID criteria now exist for judging and predicting with confidence the behavior of a given plastic material under a proposed difficult environment; and much experimental evidence is available to the corrosion engineer to help him in his analysis.

Invariably no one material exactly fits the service one might have in mind, but an educated opinion perhaps supported by some simple tests can be valuable. It is the purpose of this discussion to remove some of the needless mystery which veils the structure-versus-performance characteristics of a plastic by analyzing a few situations involving successes and failures in order to bring to light the pertinent reasons for both.

The chemical structure and composition of a plastic or resin must be known and understood before one can speculate intelligently about its usefulness under a given set of conditions. The natures of the environment and the plastic must be compared in order to judge whether they will have any effect on each other, the judgment being partly based on whether the two are very much alike, very different or more different than alike.

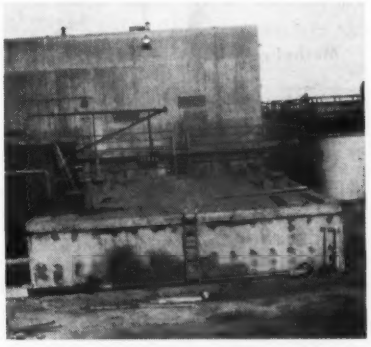
Resins Classified According to Polarity

The first criterion for the comparison is designated "polarity." This term reflects qualitatively the distribution of electrical charges in a material. For simplicity it might be stated that polar materials are "water loving;" non-polar materials are not. It is the chemical structure of a material which determines this and a classification of groups by polarity that is useful follows:

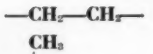
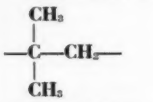
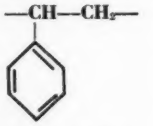
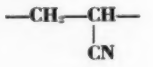
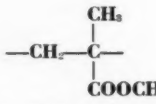
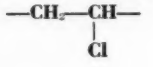
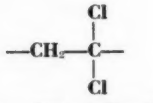
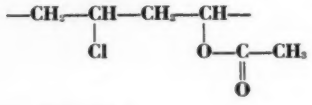
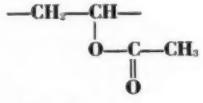
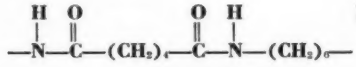
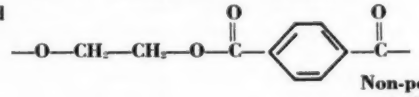
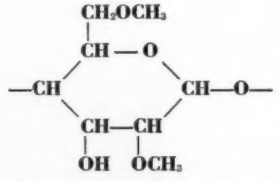
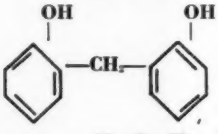
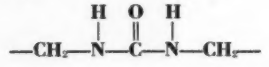
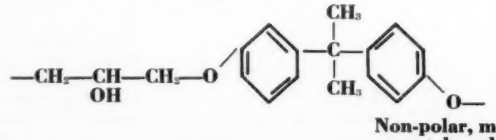
Polar	*Slightly Polar*	*Non-Polar*
—OH	—Cl	H—
—COOH	—Br	CH_3—
—SO_3H	—CN	$C_{17}H_{35}$—
—OCH_3	—S—	C_6H_5—
O ‖ —C—OCH_3	O ‖ —C—N <	kerosene
O OH ‖ / —OP		oils, fats
\ OH		
O ‖ —C— —NH_2		
salts acids bases		

A plastic or resin is in general made up of a long and often complex "backbone" of non-polar carbon atoms from which may hang either polar, non-polar, or slightly polar appendages; or the backbone may itself contain some polar groups as individual connecting "bones."

To depict this backbone and appendages in its entirety would be too cumbersome and chemists are therefore content to write structures for only a small segment of the chain or network. This gives a fairly accurate representation of what is termed a repeating unit; several hundred of these, for example, linked together make up the individual molecules



End view of the vanadium extraction circuit during construction. Economics showed that concrete construction would be cheaper than wood provided that the concrete could be protected against the solvent-acid leach liquor mixture

Product	*Structure*	*Classification*
Polyethylene		Non-polar
Polyisobutylene		Non-polar
Polystyrene		Non-polar
Polyacrylonitrile		Non-polar, slightly polar
Polymethyl methacrylate		Non-polar, moderately polar
Polyvinyl chloride		Non-polar, slightly polar
Polyvinylidene chloride (Saran)		Non-polar, slightly polar
Vinyl chloride-vinyl acetate copolymer		Non-polar, moderately polar
Polyvinyl acetate		Moderately polar
Polytetrafluoroethylene (Teflon)		Non-polar
Nylon (Polyamide)		Non-polar, moderately polar
Dacron (Saturated Polyester)		Non-polar, moderately polar
Methyl cellulose		Polar
Phenolic resin*		Non-polar, slightly polar
Urea-formaldehyde*		Polar
Epoxy Resin*		Non-polar, moderately polar

* See text under thermosetting resins, top of page 59.

TABLE I. Molecular Structure and Classification of Plastics

which comprise the resin or plastic. Some of the better known resins are depicted in Table I and are classified according to polarity as judged by the preponderance of one type of structure over the other. Resins which show intermediate characteristics are given two classifications.

If there is evidence of overwhelming polarity, whether in the backbone itself or in appendant groups, in the absence of other contributing factors it is predictable that the plastics would be swelled or perhaps even dissolved by water, aqueous solutions, or even polar materials such as alcohol or acetone. Polyvinyl alcohol and methyl cellulose, among the structures depicted, would fall into this category and would therefore not be used in service involving aqueous solutions. They might have use, however, in service involving protection against non-polar solvents such as benzene or kerosene.

Polyethylene, which is essentially non-polar, would be predicted to have very good resistance to water, aqueous solutions and polar organic materials (alcohol, acetone) but would be swelled or dissolved by non-polar solvents such as kerosene or carbon tetrachloride.

There are exceptions to this inasmuch as the mere classifying of a material as either polar or non-polar may be misleading. For example, the fluorinated polymer Teflon has been classified as non-polar, and yet has no solubility in the usual non-polar solvents. This is a consequence of its unique perfluoro structure with its resultant close packing, high symmetry and high degree of crystallinity. In the main, however, the polar—non-polar criterion is very useful.

Effect of Spatial Structure on Performance

A second criterion for judging prospective performance of a polymer depends upon its spatial structure, upon whether it is linear, branched or crosslinked (multi-dimensional).

Plastics and resins are classified into two types, thermoplastic and thermosetting, and this is defined by the spatial structure referred to.

A thermoplastic resin is invariably linear or somewhat branched and will undergo no permanent change when heated below decomposition temperature. It will soften and may even melt, only to solidify again on cooling. This may be repeated more or less at will without altering the resin to any great extent. Polyethylene, nylon, polyvinyl acetate, etc., exhibit such behavior.

Thermosetting resins are broadly characterized by an initial softening at high temperature, but become progressively harder with continued heating. In the idealized case these will set to a hard, rigid, infusible mass. Such materials as the urea-formaldehyde and phenol-formaldehyde resins are thermosetting types and are the ones marked by an asterisk in Table I. They are characterized by a crosslinked structure wherein linkages extend between chains with the result that two and three dimensional structures may be built up—the more crosslinks, the more rigid the structure. Enormous molecular weights are achieved in this manner and the resultant product is infusible and will merely char and decompose if heated to high temperatures. The term thermoset is perhaps misleading, because many crosslinked structures are produced without benefit of high temperature; curing being achieved by low temperature reactions which are often of the same type that produced the linear polymer. The terms thermoset and crosslinked, therefore, should be considered roughly analogous.

One important consequence of the crosslinking reaction is that it confers relative insolubility on the polymer. Thus, while a linear urea-formaldehyde polymer, because of its highly polar nature is substantially water soluble, the crosslinked thermoset material is hardly affected by water or most simple aqueous solutions. Crosslinking of other water-soluble polymers, such as starch, glue, or polyvinyl alcohol, can convert these into intractable insoluble materials, useful for paper sizing, for example. Crosslinking of natural rubber (the vulcanization process) converts it from a soft low melting material, soluble in benzene and other hydrocarbons, to one having the characteristics familiar to us.

Group	*Occurrence*	*Attacking Reagents*
Tertiary hydrogen (—C(H)—)	branched polyethylene	oxygen in ultra violet light
Double bond unsaturation (—C=C—)	natural rubber	ozone, conc. halogen acids, strong oxidizing agents
Nitrile (—C≡N—)	acrylonitrile polymers	strong caustic or hot weak caustic, hot strong acids
Ester (—C(=O)—O—R)	methylmethacrylate, Dacron, alkyds	strong caustic or hot weak caustic, hot strong acids
Amide (—C(=O)—N=)	nylon, urea resins	strong caustic, hot weak caustic, hot strong acids
Phenolic hydroxyls (—OH)	phenol-formaldehyde	caustic, oxidizing agents, strong nitric and sulfuric acids
Carboxyl (—C(=O)—OH)	hydrolyzed polyacrylonitrile	weak alkalies
Phenyl	polystyrene	Vigorous oxidizing agents, concentrated sulfuric and nitric acids
Polysulfide (—S—S—)	thiokol	oxidizing agents, alkali

Relatively Inert Functional Groups

Chloride —Cl	Methoxy —OCH_3
Fluorine —F	Ether R—O—R

TABLE II. Function Groups and Reagent Susceptibility

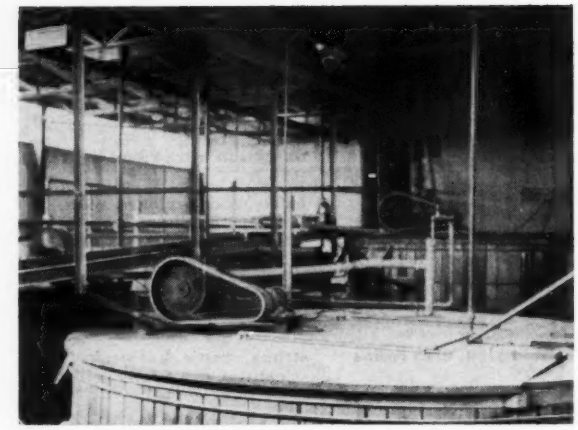
Reactive Structural Groups May Be Chemically Vulnerable

Yet a third criterion is useful in judging chemical resistance of a plastic or resin, namely the presence or absence of chemically reactive groups. These comprise regions of potential vulnerability to chemical attack, and so contribute to the defining of the severity of service to which the resin may be subjected.

Table II lists functional groups (as they are termed in organic chemistry), typical resins wherein these may be found, and reagents which are known to attack these groups. Relatively inert functional groups are included for comparison.

Again some qualification is necessary inasmuch as the internal structure of the resin in the neighborhood of the specific group under consideration will have effect on whether the functional group exhibits its susceptibility easily, with difficulty or even not at all. For example, the ester group is susceptible to relatively facile hydrolytic cleavage by weak base or even weak acid when it is contained in a simple small molecule such as methyl acetate. Cleavage becomes much more difficult in a heavier molecule such as octadecyl stearate because of its relative water insolubility and because the functional group is virtually buried in the molecule. The hydrolysis (cleavage) of methyl acrylate proceeds more readily than that of methyl methacrylate, and when the monomers are converted into their respective polymers the shielding provided by the extra methyl group in the latter makes the polymer resistant to both weak alkali and even fairly strong acids. Crosslinking reactions also serve to bury functional groups to an extent so that they are less vulnerable to attack.

Although the preceding by no means exhaust the criteria by which resins and plastics may be judged for a specific application, the remaining ones are perhaps more subtle and would deal with finer points of interior structure. The three listed, however, allow a general weeding-out process to be applied. Thus, for high temperature operation one would not choose a low melting thermoplastic; for service under alkaline oxidizing conditions a phenol-formaldehyde polymer would be grossly unsuitable, while polyethylene would not be useful in a uranium solvent extraction circuit where kerosene is the carrier solvent.



Stripping in the mixer-settlers of the vanadium stripping circuit is accomplished with 20 percent sulfuric acid at 140° F

Practical Applications at Shiprock Mill

The Shiprock mill of Kerr-McGee Oil Industries has been a fortuitous proving ground for a variety of resin and plastics. Operating conditions range from very mild to inordinately severe. By no means can all the protective measures examined there on a plant scale be termed successful; many, on the other hand, were effective and impressively so. Knowledge gained from both failures and successes will undoubtedly be useful.

A brief review of the operations of the Shiprock mill is informative as regards the variety of processes which have been employed in recovering uranium and vanadium.

Sulfuric acid leaching of crushed and wet ground uranium ore at elevated temperature and in the presence of sodium chlorate oxidant affords a leach pulp which is clarified in a thickener-classifier system. Clarified pregnant liquor was at first treated by ion exchange for recovery of the uranium, while the vanadium was recovered as a "brown cake" by oxidation and heating of the uranium barren liquor. Elution of the loaded ion exchange resins was with ambient to warm 1 N NaCl – 0.1 N HCl. More or less regular rejuvenation of the resins was required to free them of poisoning constituents which were irreversibly deposited in service (titanium, zirconium, phosphate, silica and molybdenum, among others). This consisted of treatment with moderately strong alkaline solutions, preceded or preferably followed by 42 percent sulfuric acid.

Improvements in technology led to the pioneering adoption of the phosphate solvent extraction process for uranium and eventually for vanadium. Uranium loaded solvent is stripped by soda ash, a trouble free environment as regards corrosion, while the vanadium-loaded solvent is stripped at 140° F with about 20 percent sulfuric acid. Prior to solvent extraction, the leach liquor is reduced with sulfur dioxide to eliminate process interference by ferric iron.

The early history of the mill's operation was one of mixed results as regards the endurance of the plastics and resins employed. There were some severe failures; on the other hand, some of the products have given uninterrupted reliable service for over six years.

Heavy Protective Coat Needed in Tanks

A number of steel tanks were constructed for holding pregnant leach liquor at ambient temperature and for holding chloride eluant liquors. After sand blasting and cleaning they were primed and painted with a furane resin over a fiber glass net. Total thickness was about 20–25 mils. After curing, the coating was spark tested for "holidays" and put into service. At intervals it was necessary to clean these tanks of accumulated sludge or to pick out a stray hard hat or tool.

Failure of these linings was progressive and not a single coating survived; the tanks kept at elevated temperature being the first to yield.

In retrospect, some of the contributing difficulties are better understood than they were seven years ago, and it is evident from perusing the literature that the company's difficulties were experienced elsewhere.

Contributing to the failures were the following:

(1) Spark testing was too drastic and damage was incurred in the testing itself.

(2) Coating was too thin. A coating for continuous immersion service should be at least 1/16 in. and preferably 3/32 in.

(3) The 20–25 mils coating was readily susceptible to mechanical damage from a dropped hard hat, tool, or even a broom handle. Result was that any maintenance invariably caused additional damage. Accordingly, the principal causes for failure seem to have been mechanical. The furane resins are markedly resistant to attack by non-oxidizing acids and would have been expected to provide good service. They are, however, quite brittle and apparently plasticizing techniques which might have made them more resistant to mechanical damage had not been successfully developed at the time of the installation.

Many of the tanks are still in operation; all have been relined with polyester-glass fiber, however, or given heavy coats of neoprene paint, both of which seem to be quite satisfactory.

Tailings Line Replaced with Wooden Pipe

A second example recounts difficulties experienced in disposal of a tails solution derived from recovering vanadium in the pregnant liquor. The tails solutions were essentially at the boiling point, acidic, and contained some excess chlorate-chlorine and significant levels of oxidized vanadium. Approximately 2000 ft of eight in. fiber glass-polyester low pressure tubing was laid on an even grade to the tailings pond. Sections were cut on a bias and joined together with resin and taped. The whole was anchored only at the midpoint, and a six to eight ft length projected out over the rim of the tailings pond.

Within minutes after the boiling liquor was sent through the tubing, the end collapsed. There were almost daily failures at the joints. The thermal shock to which this material was subjected was brutal, ambient temperatures during the early days of operation often being below zero while the liquor was at the boiling point. Service was intermittent; the thermal shocks with their associated expansion and subsequent contraction coming about four times daily. Contraction was often so violent that the joints would be crushed. Eventually the entire installation was replaced with wooden pipe.

A variety of opinions have been expressed about the reasons for failure. The joints were unquestionably weak spots, and anchoring at regular intervals would have minimized the violent expansion-contraction cycles. Similar fiber glass tubing today is greatly improved and undoubtedly more reliable.

A wooden tailings line for such

service also has limitations, principally that seepage through the staves occurs and the metal bands, even though protected, are eventually attacked.

Plastic Applications in Ion Exchange Operation

The original flow sheet employed the ion exchange process for uranium recovery. Rubber-lined ion exchange columns contained the resin and all solutions were fed through Saran-lined steel pipes and rubber-lined air-actuated Saunders type valves. Additional piping, carrying ambient pregnant liquor to and from storage and to vanadium processing, was Uscolite rigid polyvinyl chloride. The ion exchange unit and its associated valves and pipe handled all the corrosive feed, eluant and rejuvenation solutions (including warm 42 percent sulfuric acid and warm 10 percent sodium hydroxide) uneventfully.

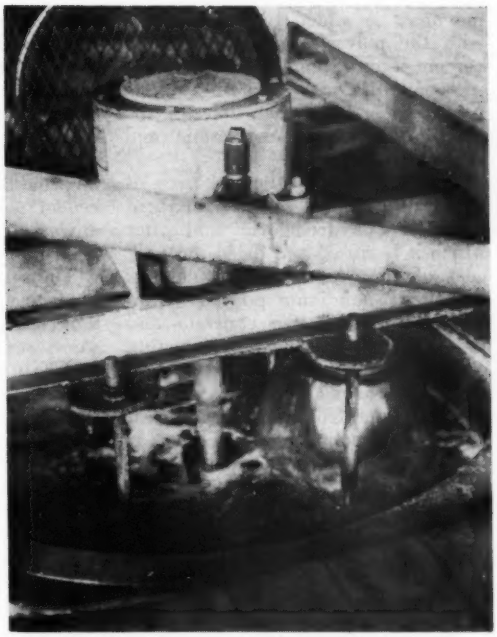
The corrosion resistant materials involved here were rubber, polyvinyl chloride, and polyvinylidene chloride. All are non-polar materials suitable for service with aqueous solutions, no organic solvents being involved. Rubber is unaffected by either dilute hydrochloric acid or alkali at about any concentration. Very strong hydrochloric acid, 12 Normal for example, can attack rubber to give the hydrochloride, but such service was never contemplated.

Saran and polyvinyl chloride are essentially inert to acids and alkalies of the concentrations used at the relatively low temperatures involved. Saran, by virtue of its extra chlorine atom, apparently becomes a little more susceptible to attack by alkalies at higher temperature, but polyvinyl chloride is relatively inert.

Linear Polyethylenes Used in Vanadium Precipitation Operation

Perhaps the most strenuous conditions to which equipment at Shiprock was subjected involved continuous precipitation of vanadium oxide. This process was operated briefly on a pilot plant scale on solvent extraction strip liquors. It entailed passage of the near boiling acid, oxidized pulp through a series of small agitated reactors followed by residence of the pulp in larger agitated "depletion reactors." The hot pulp then proceeded to a thickener and finally to a filtering and drying operation.

The small reactors were first built of wood and they disintegrated in a few weeks. Lead was used next and appeared to behave satisfactorily.



The mixing compartment of the vanadium stripper is stainless steel lined with fiber glass polyester resin

For agitators, solid steel rod was slipped into Marlex linear polyethylene tubing (which had behaved well in laboratory tests), the end capped with similar material and welded, and Z-shaped bends made in the rod. These failed in service in the the hot corrosive solution, but only at the bends where the stress was highest. Had this stress been relieved by annealing, it seems probable that this relatively inexpensive material would have survived the drastic conditions encountered. The linear polyethylene has a softening point of about 250°F, is highly crystalline and has fewer of the so-called "tertiary hydrogens" of the ordinary polyethylene which are zones vulnerable to attack, by chlorine for example. The prospects for utilizing linear polyethylene in hydrometallurgical operations would seem to be inordinately good, and some of these are discussed below.

A close relative of polyethylene was also useful in the vanadium continuous precipitation process, the sulfo-chlorinated derivative Hypalon. This product was used in the form of hose for transferring vanadium oxide pulp to the thickener, etc., and held up very well in this service.

The sulfochlorination converts the semi-rigid polyethylene into a rubbery material because introduction of these functional groups interferes with the close association of adjacent polymer molecules merely by virtue of bulk. Close association of the molecules in polyethylene promotes crystallinity and therefore rigidity, which if eliminated allows the rubbery qualities to appear. Tertiary hydrogens in polyethylene which are vulnerable to attack by oxidants, for example, are to an extent eliminated and replaced by the more inert chlorine or sulfochloro groups with the result that the modified polymer exhibits much more resistance to oxidation. A small increase in polarity of the polymer does not overbalance the fundamental non-polar nature of the backbone, so this characteristic remains largely unchanged and the product becomes more suitable for use under the conditions described.

Concrete Tanks Lined with Paraline—FG

Recent changes in the economical picture have intensified interest in vanadium at Shiprock and prompted a revamping and enlarging of both solvent extraction circuits, an undertaking completed early in 1960. The mixer-settler circuits for both uranium and vanadium extraction, formerly round and of wood construction, were redesigned rectangular. Economics showed that if concrete could be protected against the solvent-acid leach liquor mixture, this construction would be considerably cheaper than wood. For this service the fiber glass supported polyester resin Paraline—FG was chosen. This application has been eminently satisfactory.

The basic resin is a mixed polyester of isophthalic and maleic acids with both ethylene glycol and diethylene glycol. Such partly unsaturated resins are substantially linear when prepared and applied, but under influence of peroxide initiators undergo vinyl type polymerization to cure to a "thermoset" state. In order to plasticize this system to an extent and so reduce its brittleness as well as to promote polymerization, styrene

monomer is added to copolymerize with the polyester resin (about 25 percent styrene) and the whole mixed with the initiator, methyl ethyl ketone peroxide. A little heat initiates the reaction, which is exothermic and continues of its own.

For application, the concrete is first neutralized by a wash with about 10 percent hydrochloric acid after which it is rinsed and dried. A "gel" coat of four to five mils thickness containing aluminum powder is applied. This seals the concrete and provides an electrically conducting surface for subsequent "holiday" testing. (For coating steel tanks the aluminum is omitted from the gel.) An additional function of the gel coat is to prevent contact of the concrete (or steel) with the fiber glass which is mixed in with the succeeding coat; this averts wicking action to the concrete in the event the coating fails.

Method of Applying Resin Described

A two-nozzle gun feeds polymer-dissolved-in-styrene and catalyst and these are mixed in the spray pattern. At the same time a venturi tube on the gun feeds chopped roving, so that a layer of fiber glass and resin is deposited, which is then compacted and smoothed to about 1/16 in. depth with felt rollers dipped in styrene. Finally, a second thin gel coat containing no glass is applied and the whole allowed to cure.

Reference to the criteria established for judging the suitability of such a material in the service involved lends support to the reliability of the approach. The resin as deposited on the tanks can be characterized as follows:

Polar non-polar characteristics are well balanced so that it would show good resistance to penetration by either wholly non-polar solvents (kerosene, benzine, etc.) or wholly polar solvents (water, dilute acid, acetone and the like). It would not, however, be suitably resistant to a solvent having equally well balanced polar non-polar character, as for example, ether, methyl, ethyl ketone, or tributyl phosphate. These would not dissolve the resin because it is crosslinked, but would soften it by penetration if applied in relatively concentrated solution. The uranium solvent extractant contains five percent tributyl phosphate, but laboratory studies showed that this was a safe level, softening occurring only at about ten percent concentration or higher. Residual unsaturation in the polymer would make it susceptible to attack by oxidants, while hot strong alkali would attack the ester groups. Neither of these is present, however. The tendency of the polyesters to rigidity is ameliorated by the copolymerization with styrene, so that the coating overall would be expected to provide excellent service under the conditions envisaged. These expectations have been well founded.

The mixers in the vanadium stripping circuit are 6 by 6 ft mild steel tanks coated inside and out with the same resin, and are operating at 140°F in solvent and 20 percent sulfuric acid. These have given trouble-free performance save for one failure which was due to an accident. This mixer was patched and repaired and returned to service without delay.

Twelve-ft mild steel tanks coated with the same resin are being used in the sulfur dioxide reducing circuit for conditioning of the leach liquor before solvent extraction. This is a service for which even stainless steel is unsatisfactory, and yet this relatively inexpensive resin is giving adequate protection in this as well as in the other circuits described.

The manufacturers feel that the substitution of isophthalic radical for the more commonly used phthalic has been in large measure responsible for some of the very useful thermal properties of this resin. This is one of the fine points of detailed structure referred to above.

This resin has apparently given satisfactory service in HF-HNO_3 pickling of zirconium tube, in copper electrolytic cells, in boiling salt brines, etc., and seems to have earned a secure niche for itself in hydrometallurgy.

Sand Classifier Protected with PVC Product

Paraline-RD is a polyvinyl chloride product which is applied as a heavy plastisol and cured to a tough abrasion-resistant coating. In this process, polyvinyl chloride is finely ground, mixed with pigment, stabilizer and a plasticizer in which it is insoluble at ambient temperature, but with which PVC is miscible at the "curing temperature." Application to the sand classifier flites was by dip coating and curing at about 350°F, a ¼ in. coat being applied with an additional ¾ in. diam bulb applied to the leading edge of the flite. This has given excellent abrasion resistant service. It is not recommended for such service at high temperatures nor even at low temperatures for wet abrasion at high velocities (e.g., high speed stirring of abrasive slurries). Some of the Shiprock thickener mechanisms are covered with this material and it is being used in launders, tanks, etc.

Simple to Install High-Impact PVC Pipe

Also to be found in reliable service at Shiprock are high-impact PVC pipe for disposal of solvent extraction tailings liquors. These contain some solvent as entrained material, but apparently the tributyl phosphate level is low enough that the pipe is unattacked.

The Kermac mill at Grants employs this pipe throughout the solvent extraction circuit to carry both the acid liquors and the amine-isodecanol-kerosene solvent. These solvents are overwhelmingly non-polar and so do not attack the PVC. The particular virtue of using high impact PVC is that field installation is relatively simple because of the technique of welding sections together with PVC rod and hot gases; no threading is necessary.

As gasketing material for lines involving solvent or mixtures of solvent and acid liquor, Hycar rubber is used. This is the butadiene—acrylonitrile copolymer which is resistant to kerosene and similar hydrocarbon solvents by virtue of the nitrile groups. Saran cloths are handling hot acidic oxidized pulps for filtering the vanadium red cake.

Because of its cost, Teflon is used for jobs that only an equivalent material could perform. Thus in the preparation of 42 percent sulfuric acid, a Teflon pipe immersed in the diluent water carried concentrated sulfuric acid, while a second similar pipe served as an air lance for mixing and cooling. Stripping of vanadium from organic solvent in that section of the plant is achieved with 20 percent sulfuric acid at 140°F. A Teflon pipe immersed in the solvent-acid mixture delivers concentrated sulfuric acid directly to the mixer. Stainless steel is entirely unsatisfactory for this service.

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Fundamental Aspects of Mine Dust Control*

Simultaneous control of air purity, motion and heat content improves working conditions leading to increased productivity and also results in more efficient air conditioning

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Head
Department of Mining
The Pennsylvania State University

DUST control in American mines has distinguished itself primarily in two respects: (1) it has attained commendable results in the alleviation of some individual hazardous dust conditions underground, but (2) in achieving this distinction, it has displayed a singular lack of recognition of the objectives of mine dust control within the broader framework of environmental control. To paraphrase, dust control underground has succeeded locally but failed generally.

One has only to observe a single criterion—compensation cases—to establish the validity of this judgment. True, claims for workmen's compensation for silicosis and other dust-caused respiratory diseases are a retroactive barometer, but the fact that the number of such claims in America is on the increase today is evidence that mining is waging a standoff battle against its old enemy, dust.

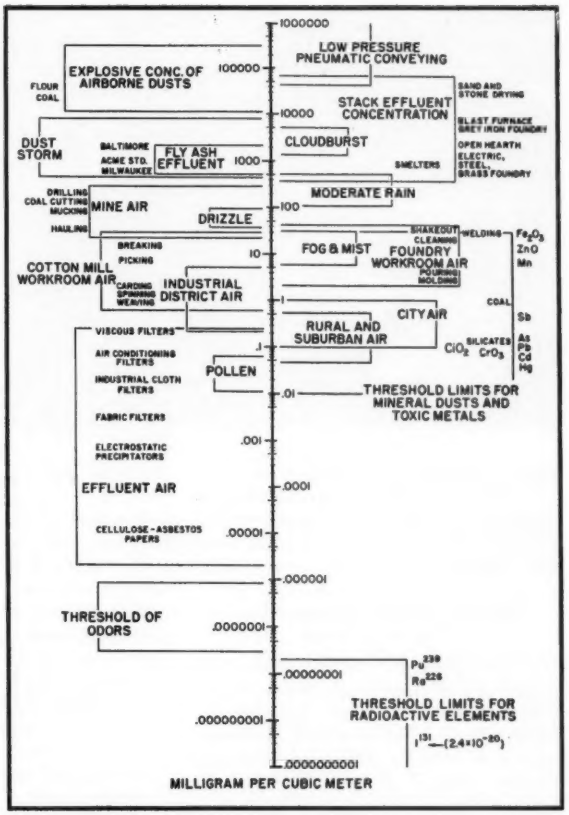


Fig. 1. Average concentration of airborne particulate matter

The reason for this situation is that mine dust control has failed to obtain recognition or practice as *a process* of mine-air conditioning and *one phase* of an atmospheric-environmental control program. For the mine atmosphere to afford a high degree of safety and efficiency, let alone comfort and cleanliness, all the objectives of air conditioning must be recog-

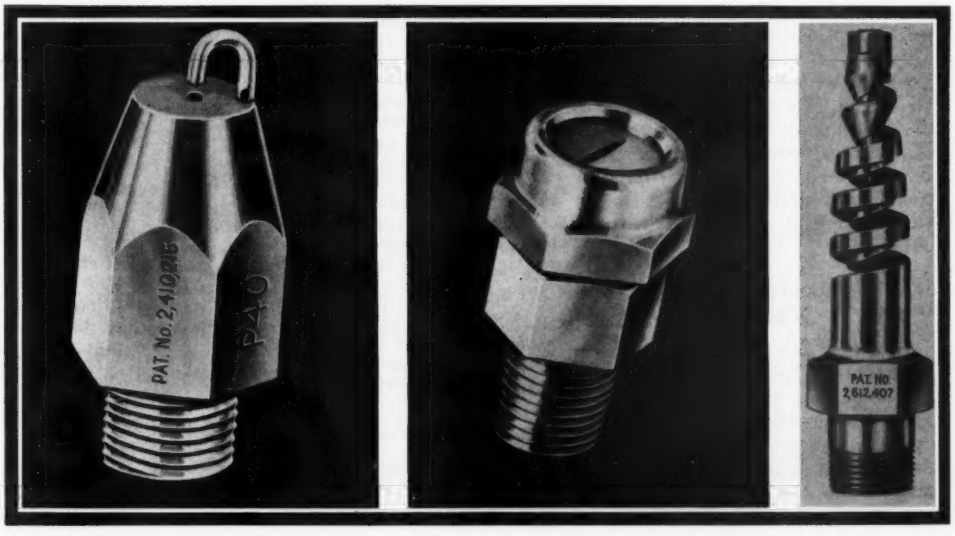


Fig. 2. Spray nozzles for mine dust control include impingement type (left), orifice type (center) and rotation type (right)

* *From Howard L. Hartman, "Mine Ventilation and Air Conditioning." Copyright 1961. Ronald Press Co. By permission of the publisher.*

Fig. 3. Directing water sprays onto a coal face during continuous mining is one means for suppressing the amount of airborne dust in the mine atmosphere

nized and met. It is futile to discuss or contemplate the inauguration of a program of mine-wide dust control divorced from the practice of total air conditioning.

Mine Air Conditioning is More than Ventilation

A new term is advocated here in place of the customary one, ventilation, to focus attention on the all-inclusiveness of atmospheric environmental control. *Air conditioning*, strictly defined, is the simultaneous control within prescribed limits of the quality, quantity, and temperature-humidity of the air in a designated space. Control of only one or two of these does not constitute air conditioning, nor does it guarantee satisfactory environmental conditions. Too little attention in mining has been given to the *simultaneous* control of purity, motion, and heat content. In his haste to correct a local gas, dust, or heat problem underground, the mining engineer tends to overlook the side effects on other working places in the mine or to relax vigilance in control of some other aspect of the miner's atmospheric environment. Not only does benefit to the working conditions result from simultaneous control (and increased comfort leads to increased productivity), but more efficiency in the air conditioning system is certain to be obtained.

Purpose of Quality Control is Two-Fold

Now that dust control may be seen in the proper perspective insofar as the total mine air conditioning program is concerned, it is beneficial to examine in detail that area involving the physical quality or purity of the air. *Quality control* is the maintaining of air within desired limits of chemical purity; the purpose is two-fold: (1) to supply clean air to a designated space and (2) to maintain the purity of the air in the space within desired limits. In keeping the oxygen content of the miner's environment above a minimum desirable level and maintaining the concentration of impurities below a maximum safe level, the mining engineer needs to be familiar with the nature of the contaminants confronting him: their properties, sources, detection, and threshold limits.

An *impurity* or *contaminant* is defined as any undesirable substance not normally present in air or present in an excessive amount. Impurities which find their way into the air can produce either chemical or physical vitiation. The following classification of impurities is based on physical state and origin, which are useful properties in devising an approach to quality control:

A. Gaseous, non-particulate contaminants
1. gases (normally gaseous)
2. vapors (normally solid or liquid)

B. Liquid particulate contaminants
1. mists (very small, liquid droplets)
2. fogs (condensed droplets of vapor)

C. Solid particulate contaminants
1. dusts (normally solid state, mineral or organic)
2. fumes (condensed vapors of solid materials)
3. smoke (unburned carbonaceous material)
4. organisms (virus, bacteria, pollen, spore)

Gases are the most common non-particulate contaminant of underground air. They vary widely in source, composition, and amount, but some are always present. Vapors from metallic ores or hydrocarbons (fuels, lubricants, etc.) occur in lesser quantity and are seldom hazardous. Likewise, liquid mists (such as oil from rock drill exhausts) and water vapor fogs are mainly nuisances.

The most common particulate contaminant, and one of the worst environmental problems in mines, is dust. Dusts originate from the ore, coal, or rock being mined. Fumes from certain metallic ores and internal-combustion engines as well as smoke from incomplete combustion (produced by internal combustion engines, blasting, fires, etc.) are irritating but constitute less severe problems. Newly recognized contaminants underground are the organisms; relatively minor in quantity, they cause less concern than other impurities.

In mine air conditioning, the two classes of contaminants which by far constitute the major problem in quality control are gases and dusts. Since they represent the two main classes of impurities (particulate and non-particulate), familiarity with their origin, behavior, and control permits the mine air conditioning engineer to cope with any contaminant. Although attention is to be focused here on dusts, *it is the most important axiom of quality control that the principles and measures applicable to the control of dusts are applicable generally to the control of all contaminants in the mine atmosphere.*

Nature of Dust Hazard in Mines

Dusts encountered in mining have widely varying effects on health and safety. Briefly, they can be classified as follows:

1. **pulmonary (harmful to respiratory system)**
2. **toxic (poisonous to body tissue, organs, etc.)**
3. **radioactive**
4. **explosive**

There is no such thing as an inert or harmless dust, let alone a "beneficial" one. *Any dust, if present in excessive amounts for a sufficient length of time, can cause pathological damage to human beings and must be considered a pulmonary dust.* Factors other than composition and concentration which determine the harmful effects of a given dust are its particle-size range, its freshness, and the susceptibility of the individual exposed.

It is obvious that, in mine quality control, stringent control measures must be applied to *all* dusts indis-

criminately. Even if dusts in the amounts present in a mine are demonstrated to be harmless to life or property, control is still warranted. If nothing worse, they are "nuisance" dusts, lessening visibility and creating uncomfortable environments. They can be nuisances psychologically as well as physiologically, resulting in labor inefficiency and dissatisfaction. Face visibility has become of much greater importance since the advent of mechanization and continuous mining; heavy dust concentrations are not only a nuisance but a hazard.

Behavior of Airborne Dusts

Airborne suspensions of particulate matter, which closely resemble gases in behavior, are termed *aerosols*. While all dusts do not have to be suspended to be harmful, those of pulmonary concern exist as aerosols.

To adequately control particulate matter in the mine atmosphere, the following basic principles of the dynamic behavior of small particles must be understood.

Reference to figure 1 at this point will be helpful.

1. Particulate matter, whether liquid or solid, exhibits remarkably similar behavior when airborne. This discussion pertains to the properties and control of solid contaminants, since they are by far the more prevalent in mine air, but the same principles apply to liquid contaminants.

2. The dust particles of either pathological or combustible consequence are predominantly below ten microns (μ) in size (10 μ = 0.0004 in.). The mining engineer should pause to consider the minuteness of the particles with which he must contend.

3. Particles larger than ten μ are unlikely to remain long in suspension in airstreams of even moderate velocity. These particles, however, are not of primary concern.

4. Industrial and mine dusts characteristically have a mean particle size in the range of 0.5 to 3 μ. Chemical activity increases with decreasing particle size.

5. The dusts below ten μ in size, which are of serious consequence in air hygiene, have no significant weight or inertia and hence can remain suspended indefinitely in an atmosphere. The expectancy that such dusts will "settle out" of the air stream is wishful thinking.

6. The control of fine dusts (below ten μ) that have become airborne requires control of the airstream in which they are suspended: *this is the basic concept of dust control.*

Principles of Mine Dust Control

Quality control is practiced through the application of three distinct programs: engineering, medical, and legal control. Only engineering control is dealt with here.

Many of the same measures are employed in dust control as in gas control. The principles and methods

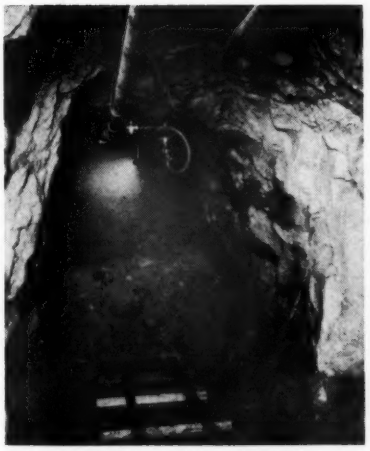


Fig. 4. Air-water spray operating in a drift following a blast

are summarized below in the general order of preference:

A. Prevention
1. avoidance by modifying operations or improving practice
2. reducing amount formed with properly maintained equipment

B. Removal
1. clean-up of workings to eliminate settled dust
2. air cleaning with dust collectors

C. Suppression
1. infusion with water or steam in advance of mining
2. allaying with water or foam in sprays, etc.
3. treating settled dust with deliquescent chemicals

D. Isolation
1. restricted blasting or off-shift blasting
2. enclosure of operation
3. local exhaust systems

E. Dilution
1. local dilution by auxiliary ventilation
2. dilution by main ventilation airstream
3. rock dusting to dilute combustible content of settled dust.

Dilution is probably the most widely and successfully used; it is applicable to almost any airborne dust condition. But basically, it may also be least preferable considering the entire air conditioning system, from the cost and general contamination standpoints: general ventilation circulates the hazard, exposing others, and pollutes the main airstream. It is seldom justified as the only control measure used but is widely employed in conjunction with other methods.

From the outset, the cardinal rule of all dust control should be remembered: *prevent dust from becoming airborne.* Every effort should be directed toward controlling particulate matter before it becomes airborne. This results in the simplest and cheapest dust control, in mines as well as in industry, underground as well as on the surface. Once the solid contaminant becomes airborne, the control task is rendered immeasurably more difficult and costly. Now the objective is to control the airstream in which the dust is suspended and to attempt to re-capture the particles which escaped into the air, where practical. This is easier said than done.

In general, those operations in the mining cycle that are primary (creative) sources of dust produce a high proportion of airborne dust. These include blasting, cutting and shearing, continuous mining, and drilling. Drawing chutes and dumping cars, while secondary (dispersal) sources, also raise much airborne dust.

General Control Measures Outlined

Dusts are contaminants formed almost entirely by artificial rather than natural means. Control measures are accordingly designed for application to particular mining operations. Some are restricted to one operation while others are more general in application. Those having general usage are discussed briefly below.

Ventilation. Either auxiliary or main ventilation may be employed to dilute and remove excessive concentrations of airborne dusts. The minimum air velocity necessary to insure adequate dispersion is that corresponding to the lower limit of turbulent flow. In most mine openings, this critical velocity is of the order of 10 to 30 fpm; but at least 50 to 100 fpm should be maintained at the face as a safety factor and to insure prompt dilution and removal of contaminants. The upper velocity limit is determined by comfort and economic considerations and even in main airways ordinarily is less than 800 fpm. Since high velocities tend to raise settled dust, airflow in working places is usually restricted to a maximum of 300 or 400 fpm.

Allaying with water. The distinction between the suppression of airborne and settled dusts becomes evident with the use of water, the second most versatile of the general measures. Wetting muck piles prior to loading or spraying loaded mine cars prior to dumping are examples of methods used to suppress settled dust and to prevent it from becoming airborne.

Fig. 5. Local exhaust system used with drilling equipment. Inset shows the principal components of the equipment

The problem is a comparatively simple one and conventional spray nozzles are effective. Suppressing airborne dust is a much more difficult task. Special mist-type nozzles are necessary to produce a finely atomized spray of water (figure 2). Removing dust from an airstream is accomplished by coagulation and impingement; this requires very fine water-droplet size, intimate mixing, low surface tension of the liquid, and proper nozzle design. Surface tension can be reduced by additives (detergent type) in the water; foams are very effective in wetting certain dusts (e. g., coal) and reducing water consumption. Figure 3 shows a mist-type spray in operation in conjunction with a continuous mining machine. During blasting and for air-cleaning purposes in some dust collectors, finely atomized water sprays (fogs or mists) produced by compressed air-water nozzles must be used (figure 4). Under no circumstances should banks of water sprays alone be relied upon to cleanse an airstream of suspended dust, if the air is to be used for ventilation again. A special use of water for dust suppression is during drilling.

Water infusion. This is a technique being used abroad to suppress or prevent the formation of dust in advance of mining a coal seam. Water (or sometimes foam or steam, which is costlier but more effective) is injected into the coal ahead of the face through long drill holes, as many as four to six per face and 20 to 60 ft in length. The liquid infuses into the seam along fractures and cracks, and under pressure, penetrates a considerable distance from the hole radially, wetting the coal well. It has proven effective in reducing dust concentrations during subsequent mining, in some instances, as much as 80 percent. Water infusion originated in Great Britain (it is used in 25 percent of the dusty mines there) and has been tried experimentally with some success in the United States.

Local exhausts. Local exhaust systems, hoods, and traps have been successfully employed in the manufacturing industry for many years to control dusts around operations that can be localized. Their principal use in mining has been for drilling, either of blast holes or roof-bolt holes (figure 5). Dry exhaust systems using air to flush the holes are being used successfully on both surface and underground drilling machines, either air or electric powered. Some use has been made underground of large enclosures and exhaust systems at chutes, hoppers, bins, and transfer points in haulage. Such an installation at a shaft pocket is shown in figure 6.

Dust collectors. Dust collectors used in conjunction with local exhaust systems, for auxiliary ventilation occassionally mounted directly on loading and continuous mining machines (see figure 7), or for cleaning recirculated air in the main ventilation system, remove contaminants of the particulate-type from an airstream before discharging into the *main* airstream. They are designed to clean air of dusts, smoke, mists, fumes, pollen, etc., but are employed in mining mainly for dusts. Collectors of the scrubber type have been most adaptable to mine conditions while attaining a high efficiency in removing fine dust from the air.

Clean-up. Removal of dust from haulageways and working places by periodic and frequent clean up constitutes good housekeeping and smart dust control in mines. Settled dusts which are removed in this way are prevented from ever again becoming airborne.

Chemical Agents. Deliquescent and binding chemicals are being used to suppress dusts in roadways and haulageways in mines. The hard crust formed makes for improved travel as well as less dust. Calcium chloride

Fig. 6. Local exhaust ventilation system on the car dump at a shaft pocket

is typical of the deliquescent chemicals and lignin sulfonate of the binders commonly used. Treatment of coal stored in stockpiles by this technique has been termed de-dusting.

Rock dusting. This is a very widespread control measure used in coal mines to combat explosive dusts. Inert (incombustible) dust is sprayed by machine dry or wet on the roof, floor, and ribs in all working places and haulageways to reduce the explosibility of settled coal dust. The Bureau of Mines requires rock dusting to within 40 ft of the face. The incombustible content of settled dust samples after rock dusting must constitute 65 percent or more by weight, with an increase of one percent for each 0.1 percent methane present. A dust as nearly inert, physiologically, as possible should be employed in rock dusting; limestone (calcium carbonate) is most widely used. Barriers consisting of bags of rock dust have been located at intervals in coal mines to stop the propagation of dust explosions. Results have been successful in some experiments, but additional development work is necessary for commercial application. Studies of dust shelves and water troughs as barriers have also been encouraging.

Proper practice. There is no substitute in dust control for safe, efficient, and proper practice in carrying out any mining operation, particularly involving blasting or the use of machinery.

When these general procedures are supplemented by the proper control measures for individual operations, then adequate dust control and efficient, satisfactory air conditioning will prevail in mines.

Calculation of Ventilation Needs

Because of the widespread reliance in mines on dilution as a means of dust and general quality control, calculation of the quantity of ventilating air required to maintain contaminants below their threshold limit or to provide a safe atmospheric environment is of critical importance.

The quantity of fresh air Q needed to dilute any impurity below its maximum allowable concentration (MAC) is found as follows:

$$Q = \frac{Q_x}{(MAC) - c} = Q_x \quad \text{(Eq. 1)}$$

where Q_x is rate of inflow or generation of contaminant and c is its normal concentration in the mine air. In this formula, the units of Q and Q_x must agree, as must those of MAC and c. With gases, the flow rates (Q and Q_x) are usually expressed on a volume basis (units: cfm), while the concentrations (MAC and c) appear as percentages. With dusts, the flow rates and concentrations may be expressed on a weight basis (units: lb/hr and gr/cu ft) or a volume and number basis (units: Q in cfm, Q_x in particles/min, and MAC and c in million of particles per cu ft of air, or mppcf). The expression simplifies to

$$Q = \frac{Q_x}{MAC} \quad \text{(Eq. 2)}$$

when (1) the rate of inflow Q_x is very small compared to Q and (2) the contaminant does not occur in normal air (c = 0). An example will demonstrate the use of these formulas.

Problem 1: **A rock drill liberates 18×10^9 particles of dust/min to the atmosphere. If the MAC is 10 mppcf and the mine air normally contains 1 mppcf of dust, find the quantity of ventilation required for dilution.**

Solution: $Q_x = 18 \times 10^9$, $MAC = 10 \times 10^6$, $c = 1 \times 10^6$

$$Q = \frac{Q_x}{MAC - c} = \frac{18 \times 10^9}{10 \times 10^6 - 1 \times 10^6} = 2 \times 10^3 = 2000 \text{ cfm}$$

It is interesting to note that this amount far exceeds the exhaust volume of a rock drill, which varies from 100 to 250 cfm, and demonstrates the absurdity of relying on drill exhaust as a substitute for good ventilation.

The dilution requirements calculated by Eq. 1 or 2 should be compared with the quantity based on the critical velocity to insure turbulent flow. Using the standard relation,

$$Q = VA \quad \text{(Eq. 3)}$$

where V is velocity in fpm and A is cross-sectional area of the working place in sq ft, the quantity can readily be determined, as this example demonstrates.

Problem 2: **Men are working in a stope 7 × 15 ft in cross section. Find the quantity to insure turbulent flow.**

Solution: **Assume critical velocity V = 50 fpm**
A = 7 × 15 = 105 sq ft
Q = VA = 50 × 105 = 5250 cfm

These simple examples demonstrate the procedure that should be followed in designing or checking the adequacy of a mine air conditioning program. If the situations portrayed by the two examples pertained to the same working place, the quantity of air that should be provided that place is at least 5250 cfm. The smaller quantity is not adequate; the velocity requirement governs over the dilution requirement, in this case.

If all the environmental control measures employed at a given mine are subjected to the same scrutiny advocated above, it is obvious that good dust control will result from good air conditioning.

Fig. 7. Wet-inertial type of dust collector on a continuous mining machine removes particulate matter from the air before discharge into the main air stream

Operators' Corner

NEW BUCKET FOR THE MOUNTAINEER*

Hanna Coal Co. "shaved" 6720 lb off the Mountaineer's new bucket to increase the amount of overburden that the shovel removes with each pass

THE Mountaineer has been dieting—it lost over three tons from its 65-yd bucket recently.

When the shovel's new bucket was brought into the welding shop of Hanna Coal Co., it weighed 174,120 lb. When it left the shop, it was a trim 167,400 lb.

There was a good reason for taking off the excess weight according to J. S. (Casey) Harmon. It was his idea that too much of the bucket's ability to "slice" through overburden was sacrificed for strength. Casey also thought the first tooth on each side of the bucket was set in too far to give the bucket the vertical stability it needed in high overburden. Faced with these two serious problems, he decided to redesign the entire bucket.

First, two new teeth were added—one on either side close to the edge of the bucket. Now the teeth bite into the overburden without having the bucket swing from side to side.

The forward edge was slimmed down, and the lip was redesigned to give it a cleaner bite without sacrificing strength. The pyramid bottom and side plates were renewed; inside the pyramid, the bulkheads had to be changed and remodeled because the handle at this section was deepened and widened.

New plate was installed on the back side of the bucket where the pyramid joins. The "U" plate reinforcing sections on the front were replaced, and the rub iron or belly band ahead of the latch bar keeper was renewed.

Because of the change in design, the liner also had to be replaced.

The new bucket has been on the Mountaineer and working in the 60-E pit near Cadiz, Ohio, since February

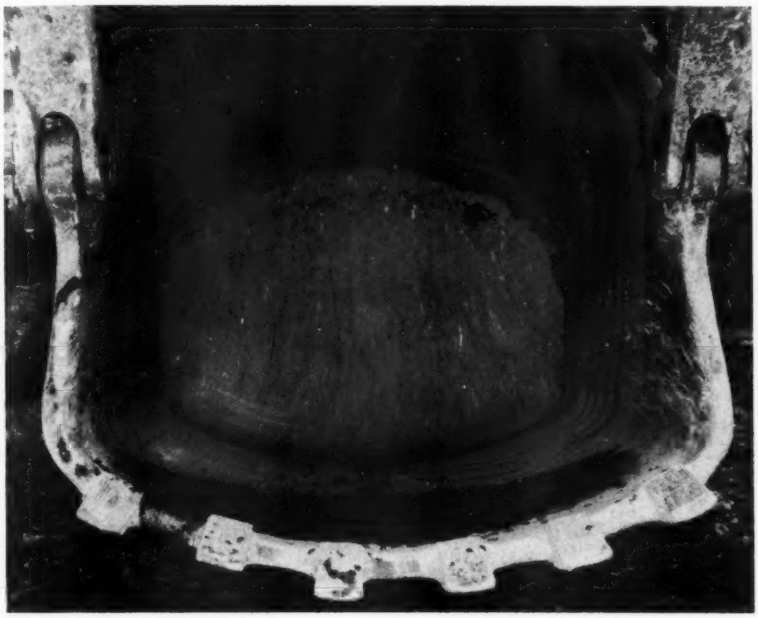
* Based on the story, "New Bucket for the Mountaineer," which appeared in the March 1961 issue of *Hanna Coal News*, Vol. 29, No. 3.

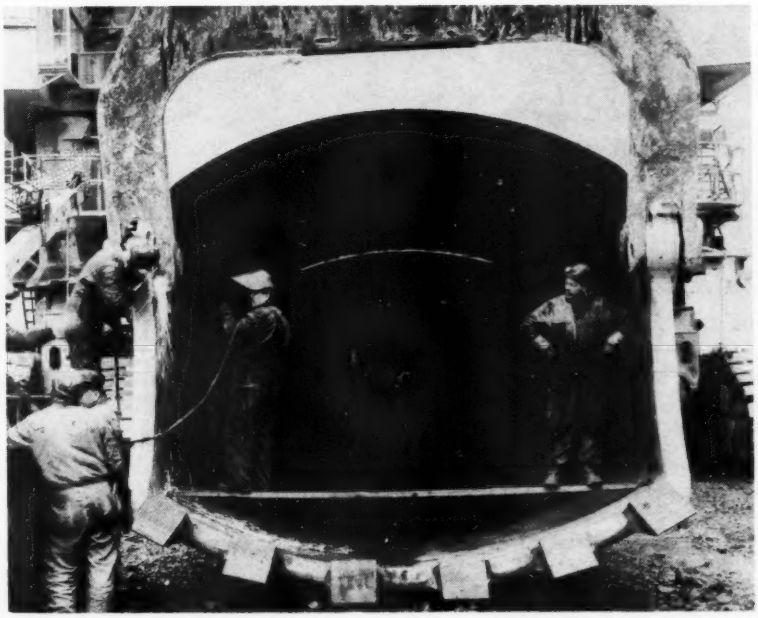
The new 65-yd bucket on its way to the pit. It took 6263.5 man-hours to rebuild

10, 1961. Because the shovel has been in low bank and cleaning the pit since the new bucket was installed, a truly significant figure so far as a comparative bucket factor is not as yet available. However, Casey Harmon believes that an additional 300,000 cu yd per year is not at all unlikely.

Shovel operators on all three shifts report that they are getting better penetration with the "slimmer" bucket and that they are moving earth easier and faster than ever before.

Remodeling the bucket took 6263.5 man-hours or 864 man-shifts. It was accomplished in 92 calendar days.





The old and the new. (Above) The old style bucket had rounded corners, a heavy leading edge, and inset teeth on either side. (Below) Welders put finishing touches on Mountaineer's new bucket which was designed by J. S. Harmon, general superintendent —the corners have been squared, the outside teeth have been moved farther out, and the leading edge has been thinned down

THE REPORT CORNER

Recent Publications of Interest to Mining Men

USBM IC 8021. "Dust Control in Mining Tunneling and Quarrying in the United States, 1955 through 1957," by Floyd G. Anderson, and R. L. Evans.*

USBM RI 5767. "Flotation of Beryl from Northeastern Pegmatities; A Progress Report," by John E. Shelton.*

USBM RI 5721. "Preparation Characteristics of Coal from Preston County, W. Va." by T. E. Gray and E. R. Palowitch.*

USBM RI 5719. "Development and Operation of a Pilot Plant for Feeding Bituminous Coal Slurry to a Pressure Gasifier," by W. R. Huff and L. F. Willmott.*

USBM RI 5746. "Determining the In-Place Support of Mine Roof with Rock Bolts, White Pine Copper Mine, Mich.," by Robert H. Merrill, Thomas A. Morgan, and C. J. Stehlik.*

USBM IC 8007. "Heavy Liquids and Procedures for Laboratory Separation of Minerals," by J. S. Browning.*

*** Available from Publications Distribution Section, Bureau of Mines, 4800 Forbes Ave., Pittsburgh 13, Pa.**

USBM IC 7984. "Fluorspar Mining Methods and Costs, Ozark-Mahoning Co., Hardin County, Ill.," by Harold Baillie, E. Powell, William Melcer, and F. J. Myslinski. Superintendent of Documents, Government Printing Office, Washington 25, D. C.

USBM IC 8017. "Summary of Mining and Petroleum Laws of the World," by Northcutt Ely. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price: $1.00.

USGS Bulletin 1098-A. "Geochemical Studies in the Coeur d'Alene District, Shoshone County, Idaho," by Vance C. Kennedy. Section on Geology by S. Warren Hobbs. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price: $1.25.

USBM RI 5675. "Field Test for Cesium and Rubidium," by K. C. Dean and I. L. Nichols. Superintendent of Documents, Government Printing Office, Washington 25, D. C. Price: 15 cents.

Bulletin 20. "Directory of Known Mineral Enterprises 1960 (Montana)," compiled by Frank A. Crowley with List of Active Coal Mines 1960 by Thomas Morgan, and Section on Mineral Industry of Montana in 1960 (USBM Area Report B-83). Montana Bureau of Mines and Geology, Montana School of Mines, Butte. Free.

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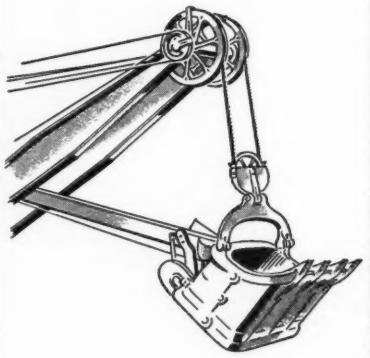
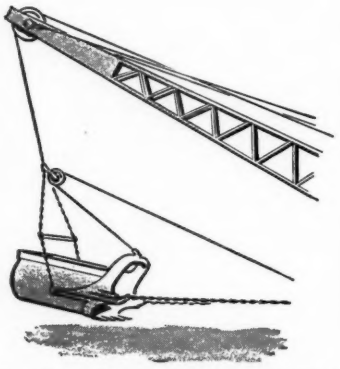


NEED RESISTANCE TO ABRASION?



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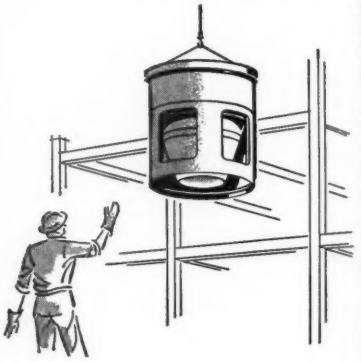

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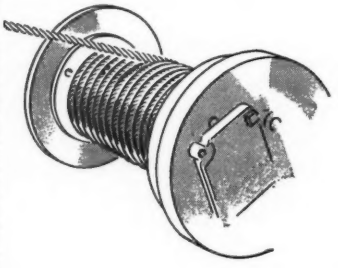

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As Viewed by HENRY I. DWORSHAK of the American Mining Congress

SECRETARY of the Treasury Douglas Dillon has indicated that the Administration is not alarmed by prospective deficits in the Federal budget. In a speech to the American Society of Newspaper Editors, he referred to the expected $2.2 billion deficit in the current fiscal year, which ends June 30, and then stated: "Such a deficit is not a cause for alarm in times like these. On the contrary, it is a stimulus to recovery that can, and should, be readily offset by surpluses as prosperity returns."

Secretary Dillon continued: "Another deficit is in prospect for fiscal 1962: one of about $3 billion. This, too, will be entirely appropriate. The economy will require the stimulating effect of a modest deficit in the coming fiscal year if it is to move forward at an adequate pace."

RESIDUAL OIL IMPORTS UNDERGOING REVIEW

The Government's residual fuel oil import control program is being formally reviewed to determine whether it meets national security objectives or requires changes. Conducting the study is the Office of Civil and Defense Mobilization, which said that "some months" may elapse before recommendations are made to the President as to the need for any changes.

The review was requested by the 12 New England Senators and the New England Council, an organization of business and industry. They contended that, prior to initiation of the program in 1959, hearings were not held nor adequate consideration given to the question of whether import quotas were necessary. Import controls have an unfavorable effect on residual oil prices in New England and an adverse effect on the area's manufacturing potential, they also asserted.

★ ★ ★ ★ ★ ★

WASHINGTON HIGHLIGHTS

TREASURY: Sees deficits as no cause for alarm
RESIDUAL OIL: Import control program being reviewed
TAXES: House ends hearings on Kennedy proposals
FUELS STUDY: Committee slates public hearings
WATER POLLUTION: Senate group revises House bill
GOLD: Bill would end currency backing requirement
LEAD-ZINC: Means of handling future surpluses studied
IRON ORE: Hearing will air research needs

★ ★ ★ ★ ★ ★

OCDM has asked interested parties to show why quotas should be removed and will allow time for the filing of rebuttals.

A National Coal Policy Conference spokesman said the review is welcomed by the coal industry because "it will make more clear than ever that excessive imports of residual oil are a threat to national security by causing critical and continuing damage to America's vital domestic fuels industries."

HEARINGS ON PRESIDENT'S TAX PROPOSALS END

The House Committee on Ways and Means this month ended lengthy public hearings on the President's recommendations for tax legislation, including an extension of present corporate and excise tax rates, an "investment incentive credit," repeal of capital gains treatment on income from the sale of depreciable business property, taxation of undistributed income from the operations of subsidiaries abroad, withholding on dividends and interest, repeal of the dividends-received credit and exclusion, and elimination of the deductions for business entertainment with general tightening up in the "expense account" area.

Lincoln Arnold, chairman of the American Mining Congress Tax Committee, told the Ways and Means Committee that the mining industry is glad to see official recognition of the need for tax incentives to encourage additional investment of capital. However, he said, the industry is opposed to the repeal of capital gains treatment of income from the sale of depreciable business property (to the extent of depreciation previously taken) unless and until it is accompanied by more adequate and realistic depreciation allowances. He suggested a Canadian-type "class system," under which the taxpayer can deduct each year any amount from zero to a specified liberal maximum for each class of property, with the rates being applied on a declining balance method. Arnold also said that, if the capital gains treatment for depreciable business property income is repealed, it should be accompanied by a provision eliminating the necessity of taking salvage value into account in arriving at depreciation deductions.

Arnold presented the opposition of the mining industry to the repeal of the dividends-received credit and exclusion, to the elimination of deductibility for legitimate business expenses, and to taxation of undistributed profits of foreign subsidiaries.

The Ways and Means Committee approved on June 5 a bill extending present corporate and excise tax rates which are scheduled for reduction July 1. That will give the Committee more time to study the other proposals of the President.

FUELS STUDY RESOLUTION SLATED FOR HEARINGS

Chairman Anderson (Dem., N.M.) announced recently that the Senate Interior Committee would hold hearings June 12 and 13 on a resolution providing for a comprehensive national fuels study. The coal industry has long sought a Congressional fuels study of this type, and top industry spokesmen are scheduled to testify on the pressing need for it.

Sponsored by 63 Senators, the resolution would create a special nine-member Senate Committee to conduct a broad fuels and energy study. The Committee would be directed to report the results of its study, including "the need, if any, for legislation designed to effectuate recommendations," to the Senate not later than January 2, 1963.

WATER POLLUTION MEASURE AWAITS SENATE ACTION

The Senate Public Works Committee has approved a modified version of a House-passed bill to broaden the Federal Government's authority in abatement of water pollution. The measure is now on the Senate calendar.

Sponsored by Rep. Blatnik (Dem., Minn.), the House measure would extend the Government's pollution abatement authority to all navigable and coastal waters, whether or not there is a showing of interstate pollution as required under present law. It would also permit the Secretary of Health, Education and Welfare to order abatement of pollution; the orders would be subject to appeal to Federal circuit courts.

As reported by the Senate Committee, the bill would not change the present procedure under which the Surgeon General may bring suit in Federal courts to secure abatement, but it would, like the House version, extend the Federal sphere to all navigable and coastal waters.

Both would raise the ceiling on Federal grants to States and municipalities for construction, on a matching basis, of abatement facilities.

At earlier House hearings on the Blatnik bill, a mining industry spokesman testified that extension of Federal authority would result in complete Federal domination of pollution abatement, minimizing the importance of the work of State agencies and interstate commissions such as the highly effective Ohio River Valley Water Sanitation Commission. The mining witness also pointed out that the measure would encourage development of a single national standard of water pollution control which might not reflect the needs and requirements of local conditions.

HOUSE BILL WOULD END GOLD BACKING OF CURRENCY

Now pending in a House Banking and Currency subcommittee is a proposal to abolish the requirement that Federal Reserve notes—the great bulk of our currency—must be backed by gold reserves of at least 25 percent. Sponsors of the legislation are Reps. Multer (Dem., N.Y.) and Widnall (Rep., N.J.), chairman and ranking minority member, respectively, of the subcommittee.

Hearings on the measure were scheduled last month but were postponed when dozens of economists, bankers, business men and others asked to be heard in the short time then available for its consideration. D. H. McLaughlin of San Francisco, chairman of the Gold Committee of the American Mining Congress, has requested time to testify in behalf of AMC. The subcommittee's staff, now attempting to work out a schedule of witnesses, has not announced new hearing dates.

Treasury Secretary Dillon was slated to be the first witness, Washington observers generally believe that he supports repeal of the gold-backing requirement, in order to free all U. S. gold reserves for meeting international commitments. Although U. S. citizens cannot exchange their dollars for gold, all dollars held by foreign governments and central banks are convertible into gold at $35 an ounce.

In announcing the hearings, Multer said that "it would seem that world confidence in the dollar could be more easily maintained if it were made perfectly clear by statute that our entire gold stock (now about $17.4 billion) is available to meet liquid dollar holdings of foreign countries (now about $18.5 billion)." While there is "no prospect" that foreign dollar holdings may be presented for payment in gold all at once, Multer stated, the bill would make it "crystal clear" that, as President Kennedy told Congress in February, "the full strength of our gold stocks and other international reserves stands behind the value of the dollar for use if needed."

Multer also said that "the bill would reemphasize our determination to maintain the value of the dollar at the present ratio of $35 per ounce of gold. It is well at this time to repeat that our Government has no intention of devaluing the dollar."

Almost simultaneously with Multer's announcement, an Interior Department spokesman told the House Interior Mines and Mining Subcommittee that the "Executive Branch is opposed to the enactment of any legislation that would establish or imply a second price for gold, different from the $35 per ounce now in effect." The witness was testifying on proposed legislation to pay domestic gold miners a subsidy of up to $35 an ounce as an incentive to greater production.

U. S. gold production is at a low ebb because, despite constantly rising mining costs, the price of the metal has remained unchanged since 1934. The Interior official added: "The payment of incentives of the sort proposed by the bill would result in a situation that gold costing the Government $70 an ounce would be offered at $35 an ounce to foreign monetary authorities and American industrial users of gold." Enactment of this legislation, he said, "could lead to uncertainty about the U. S. price of gold and the stability of the dollar in world markets, and so could result in an increased drain on U. S. gold reserves."

LEAD-ZINC GROUP STUDIES BALANCING OF SUPPLY, DEMAND

Means of coping with any future world surpluses of lead and zinc are currently under study by an 11-nation working group of the International Lead and Zinc Study Group. A United States delegation, composed of representatives of the Departments of State, Commerce and Interior, is participating in the meeting, which began May 31 in New York City.

Among possible solutions to the problems of recurring surpluses—which have depressed prices of the two metals with resulting hardship to the domestic lead-zinc industry—is an international commodity agreement patterned on the tin agreement. Under this agreement (the U. S. is not a party to it), a buffer stock was established. When the price of tin is at or above a specified ceiling price, the buffer stock manager must offer tin for sale; when the price is at or below the specified floor price, he must buy tin if he has funds.

The lead-zinc working group said it would explore, among other approaches, this method of solving the problem of surpluses. It will not make any decisions, but will report the result of its discussions at the next meeting of the parent 25-nation Study Group.

(Continued on page 93)

personals

Merl C. Kelce, president of Peabody Coal Co., was among ten prominent Americans who received 1961 Horatio Alger Awards at a May 17 ceremony in New York. **Walter J. Tuohy,** president of Chesapeake & Ohio Railway, and former **President Eisenhower** were also among the recipients of this year's awards. **Raymond E. Salvati,** president of Island Creek Coal Co. and of the American Mining Congress, was a previous award winner. The award receives its name from the famous Horatio Alger novels of yesteryear and is dedicated to the American free enterprise tradition, which holds that despite humble beginnings it is possible to achieve success through hard work, honesty and desire.

M. C. Kelce

W. J. Tuohy

Kelce has been in the coal industry for 40 years, beginning as rodman in an Oklahoma mine at age 16. He became executive vice president of Sinclair Coal Co. in 1949 and retained that position when Sinclair merged into Peabody in 1955. In 1957 he was elected president and chief executive officer of Peabody. Tuohy has been associated with the railroad and coal businesses for 43 years, and has been president of C & O since 1948.

E. B. Leisenring, Jr., has succeeded **R. H. Knode** as president of Westmoreland Coal Co. and chairman of Stonega Coke & Coal Co. Knode retired after over 40 years in the coal industry. Leisenring had previviously been president of Stonega and was executive vice president of Westmoreland. At the same time Leisenring succeeded Knode as executive head of General Coal Co., Westmoreland, Inc., and Virginia Coal & Iron Co.

E. B. Leisenring, Jr.

Walter A. Sterling has retired as board chairman and chief executive officer of Cleveland-Cliffs Iron Co. He will continue as a director. Sterling joined Cleveland-Cliffs in 1919 as a mining engineer and became president of the company in 1953. In 1958 he was elected chairman.

W. A. Sterling

H. S. Harrison

Cleveland-Cliffs also announced that **H. Stuart Harrison,** president for the past year, became president and chief executive officer, and that **John S. Wilbur** was elected senior vice president. Wilbur had been vice president—ore sales and marine. Harrison moves to his new position with a background of 24 years of service to Cleveland-Cliffs, including six years as vice president and two years as executive vice president before becoming president. Wilbur joined the company in 1940 in the Ore Sales Department.

James P. Giles has been elected president and chief executive officer of American Cement Corp. He was formerly executive vice president.

E. F. VanderStucken, Jr., has become a director of Texas Gulf Sulphur Co. VanderStucken resigned as vice president and secretary of the company in January 1961, but was retained as a consulting attorney. He has been associated with Texas Gulf for 25 years.

Oscar A. Glaeser, vice president and general manager of Western Operations, U. S. Smelting Refining & Mining Co. has been elected chairman of the Utah Natural Resources Committee. He succeeds **E. I. Lentz** who is vice president and general manager of Western Phosphates, Inc.

Jean Vuillequez, vice president, American Metal Climax, Inc., was recently re-elected president and chairman of the board of the Lead Industries Association. Re-elected vice presidents were: **Joseph A. Costello,** vice president, The Ethyl Corp.; **Charles R. Ince,** vice president, St. Joseph Lead Co.; and **Simon D. Strauss,** vice president, American Smelting & Refining Co. One new director, **D. R. Carter,** vice president, The Eagle-Picher Co., was elected to fill the vacancy on the board. All other directors were re-elected.

J. Vuillequez

A team from Paul Weir Co., Inc., consulting mining engineers, has arrived in Turkey. The team's mission is to assist the Turkish government in developing the mines, mine plants, and surface and underground operations at Zonguldak, the country's leading source of coking coal, to produce and then sustain production at an initial annual level of 7,000,000 tons.

H. B. Wickey

Harold B. Wickey, former operations vice president, Glen Alden Coal Co., is chief of party. The team also includes **Dan T. Fernandez,** electrical engineer; **Wilmot C. Jones, Jr.,** mechanical engineer, and **A. E. Stuhlfire,** accountant-office manager. They were accompanied by **John E. Good,** a Paul Weir Co. vice president, who will serve as consultant in the early months of the project's current phase.

F. R. Jeffrey, president of National Zinc Co., Inc., has been elected president of the American Zinc Institute. Other officers elected were three vice presidents: **J. J. Lennon,** American Metal Climax, Inc.; **C. E. Schwab,** The Bunker Hill Co.; and **H. L. Young,** American Zinc Sales Co. Re-elected were **G. H. LeFevre,** U. S. Smelting Refining &

F. R. Jeffrey

Mining Co., as treasurer and **J. L. Kimberley,** executive vice president and secretary.

John Robert Van Pelt, president of the Michigan College of Mining & Technology, has been elected a director of Copper Range Co.

Jesse C. Johnson, director of the Division of Raw Materials, Atomic Energy Commission, has been awarded the Ambrose Monell Medal for distinguished achievement in mineral technology. Johnson also received the first Ambrose Monell Prize of $25,000 from the Ambrose Monell Foundation. Previous recipients of the medal, which was established at Columbia University in 1954, are Lloyd M. Pidgeon who made possible the economic production of magnesium metal and Edgar C. Bain for development of steel alloys. The awards honor engineers and scientists making outstanding contributions to the minerals industry.

Johnson was a consulting mining engineer before entering Government service in 1942 with the Reconstruction Finance Corp. as an engineer. He became deputy director of AEC's Division of Raw Materials in 1948 and director in 1950. He has received many honors including the distinguished service award of the Atomic Energy Commission, and is widely known for his efforts in behalf of the uranium industry and the United States' atomic energy program.

Ambrose Monell was the first president of International Nickel Co., Inc., and an 1896 graduate of Columbia School of Engineering.

Harold E. Imes has been appointed president of the Semet-Solvay Division, Allied Chemical Corp., succeeding **Albert E. Scherm** who is retiring after 20 years as divisional president. Imes has been with the company since 1922.

Fred L. Doolittle has succeeded **Barton W. Druckenmiller** as president and chief executive officer of Penn-Dixie Cement Corp. Druckenmiller was recently elected chairman.

Several personnel changes have been announced by Old Ben Coal Corp. **R. B. Starek,** who had been vice president-sales, was elected senior vice president. **D. P. Buchanan** and **R. E. Exum** were both elected vice presidents-industrial sales, while **W. C. Campbell** became vice president planning and development. **Eugene T. Moroni,** assistant to the vice president of operations, was appointed manager of mines.

Cleveland-Cliffs Iron Co. recently announced the election of two additional members to its board of directors. They are **John S. Wilbur,** vice president-ore sales and marine, Cleveland-Cliffs Iron Co., and **M. J. Zivian,** president, chief executive officer and director of Detroit Steel Corp. This action increased the number of directors to 15.

Ronald W. Thompson, former president of Interlake Iron Corp., has succeeded **General William M. Hoge** as chairman of the board. Hoge has announced his retirement but will continue as a director and consultant. Succeeding Thompson as president of the company is **T. F. Bell,** formerly executive vice president.

Joseph M. Richards, formerly general manager of Blue Diamond Coal Co., has been named vice president of operations. Richards had been general manager since 1959, having for the previous three years been assistant general manager. He first joined the company in 1947 and became an engineer at the Leatherwood mine in 1949.

Leonard C. Rose has been elected executive vice president of Colorado Fuel & Iron Corp. He has been with CF&I since 1929 and was serving as director of purchases until his recent promotion.

Thomas Bardon, president, Shattuck Denn Mining Co., has been elected a director and member of the executive committee of Chief Consolidated Mining Co.

J. Palmer Counts was recently elected a vice president of Virginia Iron Coal & Coke Co. He had been general superintendent at the company's Tom Creek, Va., operations.

Robert J. Kiechlin has been elected comptroller of the New Jersey Zinc Co. succeeding **Edward E. Schwegler.** Schwegler, who has been vice president and comptroller since 1956, continues as a vice president of the company.

John T. Sherman has resigned as assistant director for domestic procurement, Raw Materials Division, Atomic Energy Commission, to join the Atomic Industrial Forum as secretary to the newly formed Committee on Mining and Milling.

Gordon T. Bethune has been appointed comptroller of the Oliver Iron Mining Division, U. S. Steel Corp. He succeeds **Raymond D. Ryan** who has been transferred to Orinoco Mining Co.

H. V. W. Donohoo has been named assistant manager of exploration and chief geophysicist for Texas Gulf Sulphur Co. He will be headquartered in the company's Houston office, and will be responsible for all exploration activities in the Gulf Coast area. Donohoo's exploration experience includes work in Texas, Louisiana, the Western United States and Canada. He has been with Texas Gulf Sulphur since 1957.

OBITUARIES

Ernest Wittenau, retired manager of the New Cornelia Branch, Phelps Dodge Corp., died in Los Angeles March 31. Mr. Wittenau retired from Phelps Dodge in 1948 after 33 years of service with the company in Arizona. He joined Phelps Dodge in 1915 at Morenci, and was subsequently concentrator superintendent at Bisbee and then at Ajo. In 1937 he was transferred to the Morenci Branch as general superintendent. It was during his tenure at that property that the large Morenci concentrator and smelter were erected and the Morenci mine developed and brought into production in 1942. He was manager of the New Cornelia Branch at Ajo from 1946 until his retirement.

Walter Rothenhoefer, 62, retired vice president of the Coal Division, Eastern Gas & Fuel Associates, died in Mt. Lebanon, Pa., May 9.

Mr. Rothenhoefer had retired April 1, having joined Koppers Coal Co., predecessor to Eastern Gas & Fuel's Coal Division, in 1928. He became vice president of the Coal Division in 1955 and president of New England Coal & Coke Co. and Costner, Curran & Bullitt, Inc., a subsidiary of Eastern Gas & Fuel.

Opening session speakers included (left to right) Julian Conover, AMC executive vice president; Hon. John M. Kelly, Assistant Secretary of the Interior for Mineral Resources; D. E. Davidson, vice president, sales, Link-Belt Co., and chairman, AMC Manufacturers Division; Jesse F. Core, vice president-operations-coal, U. S. Steel Corp., and chairman, AMC Coal Division; Raymond E. Salvati, president, Island Creek Coal Co., and president, American Mining Congress; Rev. Lewis Raymond, Old Stone Presbyterian Church; F. Stillman Elfred, chairman of the board, Peabody Coal Co., and chairman, Program Committee; Robert M. Hardy, Jr., president, Sunshine Mining Co., and chairman, AMC Western Division; and Charles J. Potter, president, Rochester & Pittsburgh Coal Co.

REPORTS ON SESSIONS

The many new mining machines on display at the Coal Show were matched by advances in mining technology described in the convention sessions

THE Convention session got underway Monday morning, May 15, with the presentation of the Colors by a Color Guard from the Order of the Arrow, Honor Campers of the Greater Cleveland area of the Boy Scouts of America. Following the pledge of allegiance to the flag and the playing of the national anthem, an invocation was asked by the Rev. Lewis Raymond, Pastor of the Old Stone Presbyterian Church of Cleveland.

Presiding at the opening session was Raymond E. Salvati, president, Island Creek Coal Co., and president, American Mining Congress. In his introductory remarks, Salvati said the presence of the thousands of mining men in Cleveland for the Coal Show was a reflection of their determination to put coal in the top rank of our nation's fuel economy. He stressed the importance of attendance at the technical sessions, where new ideas on a wide range of important production problems would be presented, and of thorough study of the exhibits, where the most modern coal mining equipment in the world was on display.

Following his brief remarks, Salvati introduced Jesse F. Core, vice president, operations-coal, U. S. Steel Corp., and chairman, AMC Coal Division; F. Stillman Elfred, chairman of the board, Peabody Coal Co., and chairman of the AMC Program Committee; D. E. Davidson, vice president for sales, Link-Belt Co., and

Interest in the technical sessions ran high as mine operators looked for ideas to take back home

chairman of the AMC manufacturers division; and Robert M. Hardy, president, Sunshine Mining Co., and chairman, AMC Western Division. Each of the Mining Congress officials addressed brief remarks to the mining men.

A highlight of the morning session was an address by the Hon. John M. Kelly, Assistant Secretary of the Interior for Mineral Resources. Mr. Kelly congratulated the mining industry on its latest accomplishments and urged a continuation of a foresighted, self-enlightened policy. He said the nation must have a healthy, prosperous coal industry. To accomplish this end, he emphasized the necessity for the development of a long-range national fuel policy.

Following Mr. Kelly's remarks, the industry's prospects for the next 15 years were outlined by Charles J. Potter, president, Rochester and Pittsburgh Coal Co. Potter forecast that the nation would continue to make heavier demands on its fuel and energy resources. He predicted that the demand for coal by 1975 would be above 500 million tons annually. A full transcript of Potter's remarks can be found beginning at page 28 in this month's issue.

CONVENTIONAL MINING—PRODUCTION IMPROVING

Conventional mining was the subject of Tuesday's morning session at which C. C. Cornelius, executive vice president, Emerald Coal & Coke Co., Pittsburgh, Pa., presided as chairman. Virgil A. Curry, manager of mines, The Youngstown Hines Corp., Huntington, W. Va., was vice chairman.

The first speaker of the session was Clyde H. Storey, director of industrial engineering, Elkhorn Coal Division, Princess Coals, Inc., David, Ky., who discussed "Conventional Mining in Thin Seams."

Storey noted that the Elkhorn Division of Princess Coals produces approximately 5000 tpd from eight conventional loading units working in an average coal height of 30 in. Through advanced mining techniques, time study and analysis, and equipment development, the company has been able to show increased productivity each year for the past nine years. It is now producing 12 tons per manshift.

The complete text of Storey's paper appeared in the April issue of *Mining Congress Journal.*

Joe L. McQuade, senior executive vice president, Maust Coal & Coke Corp., Richwood, W. Va., presented a paper on "Mobile Multiple Shooting With Air in Low Coal." He said that substantial savings in time and shooting costs, which resulted in increased production and lower operating cost, have been realized by the introduction of self-tramming, one-man drilling and Airdox multiple shooting machines at the Tioga mine. He explained that the key to this shooting system's success is sequence values and automatic discharge tubes which allow a group of tubes to be discharged automatically with only one trip of the shotfirer to the blowdown valve. Automatic discharge heads on the shells eliminate the time necessary to replace shear strips, as was common with other type heads. Sequence valves are mounted on the machine and racks are provided to carry the required number of shells. This shooting equipment, combined with the mobile drilling machine, allows one man to perform both drilling and shooting functions. Thus, the introduction of this machine provides the mine operator with all the advantages of shooting with air, and the means to accomplish both drilling and shooting with one man within the fast time cycle needed today.

The maintenance program at Clinchfield's Moss No. 3 mine is divided into two caterogies—preventive maintenance, and on-the-spot or breakdown maintenance—according to Ballard Taylor, assistant superinendent of maintenance, Moss No. 3 mine, Clinchfield Coal Co., Dante, Va. Preventive maintenance in this case means a planned system of repair work to get maximum efficiency from the equipment. It calls for a systematic inspection of equipment and repairs before failure occurs and thereby prevents interruptions to production. On-the-spot or breakdown maintenance refers to failures and breakdowns in machines and equipment during the production shift, when only the repairs necessary to get the piece of equipment into production are made.

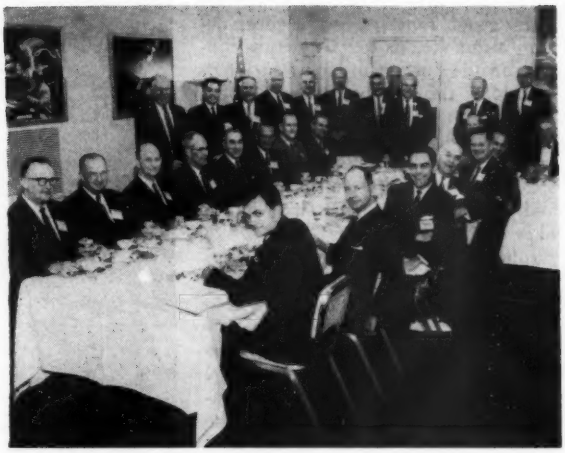
Taylor explained that the preventive maintenance crew consists of five mechanics and a foreman. Production crews are rotated to spare sections once every four days and all the equipment on the section is made available for a systematic checkup. On-the-spot or breakdown maintenance is handled in one of two ways. At two of the four portals of the mine the company has an underground shop. This station is staffed by four mechanics and a foreman. At the other two portals the company has placed a mechanic on the section with the regular production crew. With this two-system plan of maintenance, the company plans to evaluate the controversial question as to whether it is more efficient to have a repairman as a regular member of a production crew or dispatch one from a centrally located underground shop when necessary.

Taylor also described the company's system of maintenance records which allows the keeping of accurate daily, weekly, monthly and yearly records on all of the down-time for each piece of equipment in the mine.

The final paper of the session was entitled, "The Future of Conventional Equipment," and was presented by Jack Matheson, chief methods engineer, Island Creek Coal Co., Holden, W. Va. He reviewed present available conventional equipment, stressing the flexibility and tonnage potential. He also pointed out that the advantages and limitations of conventional equipment and continuous miners with regard to manpower, types of mining—advance or retreat, physical conditions of seams and markets.

In summing up, Matheson said that the increasing capacities being built into all sectional equipment by the various manufacturers, and the flexibility realized from conventional equipment, makes the future potential almost unbelievable and this equipment must be given careful consideration in the future.

Matheson's interesting paper is presented in full beginning on page 53 of this issue of *Mining Congress Journal.*



A joint luncheon meeting of the Land and Water Use Committees of the American Mining Congress and National Coal Association was held on Wednesday

MANAGEMENT AND COST CONTROLS—GETTING MORE COMPLEX

Whitney Warner, Jr., president, the Sterling Coal Co., Philadelphia, Pa., was Chairman of the Management and Cost Controls Session, Tuesday morning. His vice-chairman was Ralph B. Dean, comptroller, the Lorain Coal and Dock Co., Columbus, Ohio.

The first paper on the session was prepared by David B. Hertz and Norman O. Olson, partners, Arthur Andersen and Co., on the subject, "Profitable Control of Production and Transportation Through Operations Research." The authors, stressing the broad meaning of operations research to the coal industry, said that operations research can help in developing systematic means to assemble logically related factors which lead to making better decisions. They pointed out that operations research can not replace business judgment—it can only establish facts in a logical manner. Linear programming, an operations research technique developed in the last ten years, is especially applicable in this area. It is an analytical method of evaluating a large number of possible combinations (such as matching mines and customers) and arriving at the best combination to achieve a given objective, such as determining the combination which will provide the greatest profit.

"Saving Money through Modern Purchasing and Inventory Control" was the title of a paper by R. A. Dodds, director of purchases, Truax-Traer Coal Co., Chicago, Ill. In recent years, Truax-Traer has become increasingly conscious of the importance of supply inventory investment and has undertaken a program to keep supply inventory to a minimum. The first step was to sell management and supply personnel at each mine on the system of central purchasing and inventory control. This was done through extended visits to all locations to answer any and all questions regarding centralized purchasing.

Not having a data processing system, Truax-Traer controls inventory by having each mine warehouse send a copy of its purchase requisition to the mechanical superintendent, in the case of production equipment requirements, and to the preparation manager if the order has to do with cleaning plant equipment. These two people, who travel the properties constantly, are in a position to advise whether a purchase is indicated, or part of an excessive supply can be transferred from another location, or suggest some other procedure if indicated. A review of operating statements for the fiscal year ending six months after the inception of central purchasing at Truax-Traer compared with the statement a year later, disclosed a decrease in supply costs of nine cents per ton.

W. J. Eck, general manager, Purchasing and Stores Department, The Chesapeake and Ohio Railway Co., Cleveland, Ohio, in describing how his company controls supply costs through inventory control, said that purchasing is gaining recognition as an area in which important savings can be made. A survey of ways to improve purchasing methods at the C & O led to the development of a "Cycle Ordering Basis System" of purchasing supplies which uses for-

Ivy Baker Priest addressed a Welcoming Luncheon for the ladies on Monday

mulas that give weight to insurance costs, space rental, obsolescence, deterioration, etc., as well as factors concerning the cost of money tied up in inventory, the cost of preparing orders, and the cost of processing invoices for payment. This program has provided considerable savings to the C & O, a benefit that can accrue to a coal company also, Eck said, but it takes hard and constant work.

John Osmanski, manager of personnel, Island Creek Coal Co., Huntington, W. Va., presented the final paper on the session—Predicting Performance of Continuous Miner Operators. The paper actually was a report of the Committee on Mechanical Mining of the AMC Coal Division. The group, headed by Osmanski, has been investigating various factors which may possibly be used in predicting the performance of continuous miner operators before they are selected. Such factors as coordination, mechanical comprehension and general intelligence were considered. The study showed that none of these alone could predict operator performance; however, when the coordination, height, weight, schooling and number of dependents of a job applicant are considered together, performance can be predicted. This is the first step in a continuing study, and future reports will be made as results are available.

STRIP MINING—NEW TECHNIQUES COMING

The first of two sessions on Strip Mining was held Tuesday morning with Arnold E. Lamm, president, Pittsburg and Midway Coal Mining Co., Pittsburg, Kan., presiding. M. H. Shumate, chief engineer, Truax-Traer Coal Co., Chicago, Ill., served as vice chairman.

The first paper of the session, "Inclined Drilling and Blasting," was presented by Dr. B. J. Kochanowsky, Department of Mining, Pennsylvania State University, University Park, Pa. Dr. Kochanowsky has been conducting experiments on the use of angle holes instead of vertical holes in blasting strip mine highwalls. He has estimated that a saving of one percent in the total amount of explosives used can be made for each degree of inclination of a blast hole from the vertical. As an example, he cited the experience of General Crush Stone Co. which is drilling bore holes 20° from the vertical to shoot 40-ft benches in a basalt quarry. The powder factor has been improved from 2.97 tons per lb of explosives to 3.66 tons of broken material per lb of explosives over a two-year period. At the same time,

"Can it help us do a better job?" This was a consistent question of convention goers

drilling costs have been reduced 99 cents per ton of broken material by increasing bore hole spacing. In addition, Dr. Kochanowsky said, a 180-ft high bench is now being mined at the quarry with angle (or inclined) drilling which had been abandoned several years ago because it became too difficult to blast the toe of the highwall. He concluded by saying that sufficient evidence is on hand to lead to the conclusion that inclined drilling will spread rapidly in industry in the next few years.

E. F. Eckhardt, manager of coal mining, American Electric Power Service Corp., New York, discussed the "Economics of Large vs. Small Haulage Units." Citing experience of the Central Ohio Coal Co., Eckhardt said in 15 years approximately 110,000,000 ton miles of truck haulage with units ranging from 20 to 70 ton capacity in size had resulted in an average operating cost of $0.047 per ton per mile for haulage. Larger haulage units—40 tons or over—have proven to be the most economical method of transporting coal at Central Ohio Coal Co. Records indicate that when comparing the larger units with 20-ton units, labor costs have decreased 40 percent, operating, maintenance and supply decreased 21 percent, fuel oil costs have decreased 25 percent while tire costs have increased 40 percent. He concluded by saying that in the future, with hauls of over 15 miles, his company sees the possibility of truck trains and conveyors replacing present haulage methods.

"Combination Truck and Belt Haulage" was the title of a paper by Robert S. Humphreys, chief engineer, Stonefort Coal Mining Co., Inc., Indianapolis, Ind.

Humphreys said that certain basic conditions existed at his company's Will Scarlet Mine which influenced the original planning of the haulage system. Two seams of coal are being stripped simultaneously. The interval between the two varies from 4½-ft to 20 ft and both seams are loaded out together to facilitate blending of the raw coals ahead of the preparation plant. Because the upper level is only 50 ft wide—too narrow for large truck haulage units—and the extreme height of the interval did not allow loading upper coal into trucks running on the lower level with existing loading equipment, the company decided on a combination system of small, end-dump trucks making short hauls to a semi-portable dump hopper which feeds the conveyor. In comparing this haulage system with the last year in which all truck haulage was used at the mine, a slight saving has been made by using the combination haulage system. The total operating and maintenance cost for the truck-belt combination system was nearly equal to that for the all-truck system. Savings, however, have been made in reduced haulage road maintenance, although these savings were partially off-set by the higher depreciation for the combination system.

In concluding his presentation, Humphreys said it is difficult to make a flat statement that a combination belt and truck haulage system is more desirable or less desirable than an all-truck haulage system. Each operation must be studied from every angle, and the haulage must be made to fit the conditions.

A. M. Vance, Mining, Petroleum and Chemical Section, Westinghouse Electric Corp., East Pittsburgh, Pa., presented a paper entitled "Interconnection of Hoist and Crowd Controls—A Step Toward Shovel Automation." Pointing out that the efficiency of large stripping shovels depends in large extent upon the ability of a shovel operator, Vance described the evolution of modern shovel controls which are simpler and less fatiguing to operate, thereby allowing a shovel operator to do his job more effectively. He said that all of these new developments have set the stage for a move toward automation in shovel operation. The first step in this direction is in trying two functions together—crowd and hoist—in a simple, single control similar to the joy stick in early aircraft. This has already been done by the International Minerals and Chemicals Co. at their Florida phosphate operation where a "joy stick" control is being used on a 650B dragline. While this is a far cry

from complete shovel automation, it is a step toward progressive automation. Other improvements are on the drawing board, and on test, to exploit more fully the many advantages of all-static, high-gain, regulating control systems, Vance said.

The Vance paper was formerly discussed by R. W. Bergmann, electrical engineer, Marion Power Shovel Co., Marion, Ohio, and L. E. Blanchett, chief engineer, Bucyrus-Erie Co., South Milwaukee, Wis.

Bergmann described a joint effort by Marion Power Shovel Co. and General Electric Co. to install a crowd-hoist regulating system on a type 5761 shovel. Using an analog computer to study the effects of variable conditions such as the cutting force required and the type of bank, as well as the effect of such mechanical matters as front end geometry, a control circuit was designed and the components selected. Actual digging tests have been made with this control under various conditions which included deliberate attempts to stall the hoist motion. The tests, which are being continued, have demonstrated that automatic crowd-hoist operation is feasible.

Blanchett pointed out that there are a number of variables which will dictate the degree of interlocking between hoist and crowd controls and that much more study is needed in this area. An attempt was made several years ago to use interconnected hoist controls on a 40-yd shovel. Because control elements used at the time had a relatively slow response characteristic, the experiment was not successful. However, the fast responding static type controls available today should make this problem less critical to solve. Blanchett said that, in the case of the large shovel, automation can be an aid to the operator, however, it does not appear that it can replace the operator. It is possible, though, to provide the machine operator with a device that could be used to introduce different constants into the control system to take care of the digging variables and thereby create a proper relationship between the power units to obtain maximum operating efficiency.

The second session on strip mining was held Wednesday afternoon, May 17, with G. H. Utterback, secretary-treasurer, United Electric Coal Cos., Chicago, Ill., presiding. Martin R. Heckard, superintendent, Rapatee Mine, Midland Electric Coal Corp., Farmington, Ill., served as vice chairman.

"Application and Performance of Wheel Excavators" was the title of the first paper, which was presented by Henry Rumfelt, application engineer, Bucyrus-Erie Co., South Milwaukee, Wis. He pointed out that there are two types of wheel excavators of interest to the strip miner, especially the coal miner. One is the large type developed primarily for the brown coal industry in Germany; the other is the type developed mostly in the coal strip mines of Fulton County, Ill., usually referred to as the Kolbe wheel excavator. While both machines are called wheel excavators, they differ considerably in mechanical construction as well as in their application. In some respects, however, they are similar. For example, both are electrically powered, and a digging wheel and an internal belt conveyor system are common to both. The domestic machines are used exclusively in overburden excavation whereas the German machines may be used in either overburden removal or in coal reclamation.

This interesting paper is presented in full beginning on page 46 of this issue of *Mining Congress Journal.*

Louis F. Zager, management engineer, Helmick & Associates, Cleveland, Ohio, discussed "Auger Mining Standards and Comparative Costs." He divided auger coal mining into two types of operation: augering of highwalls left by stripping operations, and augering of outcrop coal. The first type usually requires low pit cleanup, and serviceable haulage roads are generally available. Also, the pit is usually wide enough to accommodate any of the standard augering units available. On the other hand, augering of outcrop coal requires the preparation of a working bench and haul roads with the resultant higher cost of 10 to 15 cents per ton depending on the seam thickness. The bench width varies from 20 to 100 ft depending on the augering equipment and the haulage methods used.

Zager pointed out that auger mining of coal results in a profitable operation if certain items are considered in the planning stage and during the operation. The coal seam to be augered should lay relatively flat, or pitch at a constant angle, and be free from rolls and faults. It may have impurities but wide or excessively hard horizontal bands of sandstone or other abrasive material will cause excessive wear and breakage of bits, pilots and heads. The facing up operation or bench preparation should be done in such a manner that the augering machine will have a solid footing and the bench area will have natural drainage. The site for each auger should be selected so that as much of the seam height as possible can be removed from one hole, and pillars of 4 to 12 in. thickness should be left between holes. Haulage roads should be laid out for easy maintenance and drainage, and haulage equipment of sufficient capacity must be made available to get optimum production. Highwalls should be inspected daily for potential landslides and corrective action taken. Standard operation practices should be established and enforced, i.e., preventive maintenance, working hours, quality standards and production quotas. Zager concluded that strip operators and others should consider the augering of outcrop coal seams where the conditions are such that it is impractical to strip the coal even with the newest type of stripping equipment.

"Horizontal Air Drilling" was the subject of the paper presented by N. O. Lewis, chief engineer, Robbins

Mining men devoted close study to the many new mining machines introduced at the Coal Show

Machine & Manufacturing Co., Inc., Oneonta, Ala. In the search for higher production and more versatile equipment, he said, the possibilities of horizontal rotary drilling with air are being considered by the mining industry. Successful equipment has been developed and large capacity, high production horizontal drills have been in use for over a year. The machines are of necessity large and heavy, but they are fast and will penetrate rock. The improvements and new developments are, without question, promoting horizontal blasthole drilling. Lewis expects that more and more consideration will be given to horizontal drilling in the future.

Lewis also described the twin-head or dual mast horizontal rotary drill working at the Power mine, Peabody Coal Co., Montrose, Mo. Although capable of drilling 12-in. diam holes, the machine is now drilling 6¾-in. diam holes in hard shale interlaced with pyrite inclusions—and a layer of limestock rock is often encountered. Production of over 2000 ft of drilled hole in one regular shift is not unusual in this formation, and the average penetration rate is approximately 360 linear ft of hole per hour. The drill weighs about 300,000 lb, and has a drilling pressure on each mast up to 80,000 lb, and a drilling torque of 80,000 in.-lb at speeds ranging from 40 to 120 rpm is provided with constant torque, 75-hp electric motors. The drill heads will drill forward at a maximum speed of 60 fpm and retract at a maximum speed of 120 fpm.

Lewis emphasized that horizontal drilling will not replace vertical drilling, but he said that the advantages of horizontal drilling under certain conditions should merit careful consideration. He concluded that horizontal drilling is and will become more important in the mining industry. The industry and only the industry will decide when, where, and to what extent horizontal drilling fits into the over-all production of coal.

Thomas P. Bradford, lubrication engineer, Hanna Coal Co., Cadiz, Ohio, concluded the session with a paper on "Increasing Equipment Availability Through Maintenance." He feels that maintenance must be broken down into two basic programs and treated as such to obtain increased availability. These programs are preventive maintenance and corrective maintenance.

Bradford explained that preventive maintenance is the key to the success or failure of any operation and maintenance program. Equipment is designed to meet average requirements of application and condition as encountered in the whole market. However, a proper preventive maintenance program must be designed and function with flexibility to meet conditions deviating from the average. If operating conditions are adverse, the operator must increase the manufacturer's recommended preventive maintenance program by substituting his own preventive maintenance program to obtain his original objective. Certain severe applications where normal production is in excess of design may require, in addition to increased personnel competency and preventive maintenance, a decrease in productivity in order to obtain the best unit cost. The operator cannot expect to obtain more from a piece of equipment than was designed into it without paying a premium for the additional results.

A preventive maintenance program aims to assure the full life expectancy designed into each part and the unit as a whole. The corrective maintenance program succeeds the preventive maintenance program when required. A good corrective maintenance program should incorporate two vitally important basic functions: first, an attempt to analyze the cause of failures, and second, apply corrective measures.

HAULAGE AND POWER

Joseph M. Richards, vice president of operations, Blue Diamond Coal Co., Knoxville, Tenn., presided at the session on Haulage and Power, Tuesday afternoon. A. C. Muir, electrical engineer, The Berwind-White Coal Mining Co., Philadelphia, Pa., was vice chairman.

John A. Dunn, chief electrical engineer, Island Creek Coal Co., Holden, W. Va., discussed his company's "Experience With Silicon Rectifiers." He said that Island Creek Coal Co. put its first silicon rectifier in service in mid-1959 at its No. 25 mine. This rectifier supplied d-c power to two sections of face equipment, plus the haulage locomotives hauling from the two sections. The average load was approximately 300 kw with peaks of 500 to 550 kw when haulage locomotives were on the sections. After about six months of operation, two cells in one path failed. The warning light was observed by maintenance personnel and these two cells were replaced between shifts. In almost two years of continuous operation, the mine has not had any other trouble with this rectifier.

Dunn said that since the first installation the company has installed four additional 500-kw units, and that management is completely satisfied with their performance. He believes that the silicon rectifier is the most desirable means of converting a-c to d-c for applications in or around coal mines. These rectifiers, he said, can be furnished in just about any output rating from one kw up. Low capacity rectifiers of this type can be used in a-c powered mining for operating battery charging equipment and supplying power for variable speed motors. The speaker also pointed out that it is possible that silicon rectifiers, because of their small size, can be utilized on a-c powered mining machines for operating tramming motors and variable speed drives.

A paper entitled, "Use of Brakeman Cars," was presented by Emil J. Servant, Jr., assistant general superintendent, Olga Coal Co., Coalwood, W. Va. Olga Coal Co. operates two mines in southern West Virginia which are interconnected by a track haulage system. Coal from both mines is hauled by locomotives to a shaft bottom, where it is rotary dumped into skips for delivery to the central preparation plant outside which prepares about 8500 tons daily. From the most remote section of the mines, the haul is about seven miles. Grades in excess of three percent are encountered on the main haulageways which are generally in favor of the loads. Coal is hauled in 10½-ton mine cars over 85-lb track to the shaft bottom by 40-ton tandem locomotives.

At one time, Servant explained, all haulage was with battery-powered locomotives. In an effort to speed up transportation, cut maintenance costs, and in general make the haulage system more efficient, it was decided to install trolley on all haulageways, main and sectional. Upon the installation of the trolley, it was found that the desired benefits were generally realized with one exception. The 40-ton trolley locomotives could not handle 23 loaded cars on air brakes alone down a three percent grade if the dynamic braking failed. The company decided to purchase the Sanford-Day Brakeman Car to obtain the additional braking required. With these new cars, management at Olga feels that it has served its need for additional locomotive braking capacity without having to purchase costly additional or larger replacement units, and without having to resort to undesirable skids or other devices that would reduce the reliability and efficiency of the main haulage system. From the standpoint of safety, Serv-

ant added, it can be said that the danger of runaway trips has been virtually eliminated.

Peter J. Zukow, superintendent, Mines 7 and 8, Ore Mines & Quarry, Tennessee Coal & Iron Division, U. S. Steel Corp., Fairfield, Ala., reviewed T.C.I.'s experience with diesel-powered mining equipment underground. Diesel haulage units have proven highly successful at T.C.I.'s iron ore mines where physical conditions are similar to those in most coal mines.

Zukow said dieselization is changing the company's mining picture rather dramatically. Proper recognition must be given to the problems of diesel equipment but T.C.I. finds advantages far outweigh the disadvantages. These advantages include flexibility and movement throughout a mining area, longer length haul due to no cable restriction, speed of travel, grade ability, and safety of operation. Serious consideration will be given by T.C.I. for future new mines to become dieselized to a greater degree where equipment such as locomotives, drill jumbos, service equipment and, of course, shuttle cars will be diesel powered. Use of diesel equipment, according to Zukow, will continue to increase because of its mobility, efficiency and safety in operation.

The complete text of Zukow's paper is published in full beginning on page 42 of this issue of *Mining Congress Journal.*

George L. May, division superintendent, Cambria Division, Bethlehem Mines Corp., Ebensburg, Pa., presented a paper on "Yieldable Mine Arches in Haulageways." He described the various mining methods and supports that have been used by Bethlehem Mines to control difficult roof.

One example he used was Mine No. 32 at Revloc, Pa.—a shaft operation in the Lower Kitanning seam. Average cover is 850 to 900 ft. Immediately above the coal is 8 to 24 in. of bone coal. Above the bone coal are slates, sandstones, shales and fine clay. The "B" Rider or Middle Kittanning seam is from 15 to 30 ft above the "B" seam. The company tried different types of roof support, including roof bolting and roof infusion, and investigated the possibilities of gas or water pressures below the "B" Rider seam being the contributing causes of the destructive pressure caves that occurred.

By process of elimination, May said, the company came to consideration of use of yieldable steel arches as a means of roof control. Running pressure caves, which the company had never before been able to prevent or arrest by other means, were stopped immediately with the yieldable arches. The arches yielded slightly under the tremendous pressure but did not collapse.

May also discussed the company's operation in the Elkhorn No. 3 seam at Jenkins, Ky. Here management had used yieldable steel arches extensively in haulageways and drift openings. The arches were successful in making secure, drift mine portal openings in unconsolidated roof material. Considerable cost advantage was obtained and with great improvement in safety.

"Underground Conveyor Belting in the United Kingdom" was the title of the final paper of the Haulage and Power Session. It was given by S. Weinberg, chief engineer (Specialist Services), The National Coal Board, London, England. Weinberg said that the most interesting development in underground belt haulage in the United Kingdom has been the rapid growth in the use of Polyvinyl chloride (P.V.C.). Originally introduced to satisfy safety requirements of the National Coal Board, the mechanical properties of these belts have been improved and are now providing substantial savings in conveying costs in the United Kingdom. Since the National Coal Board is responsible for 24,000 belt conveyors and 28 million ft (5½ thousand miles) of conveyor length, any reduction in the cost of belting becomes a substantial saving.

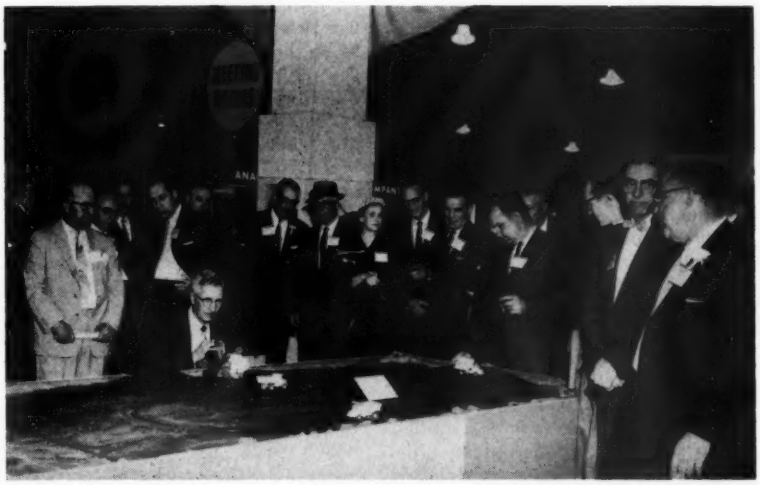
Weinberg went on to describe how the National Coal Board tests and approves belting materials, and outlined studies being carried on to improve conveyor haulage.

COST CUTTING IN OPEN PIT MINING

J. R. Kringle, executive vice president, New York Trap Rock Corp., West Nyack, N. Y., served as Chairman of the session on "Cost Cutting in Open Pit Mining" on Tuesday afternoon, and was assisted by vice chairman Carl F. Clausen, director of the Manufacturing Process Dept. of Portland Cement Association, Skokie, Ill.

"Program for Maintenance of Mobile Equipment" was the subject of a talk by Howard Hanks Jr., operations engineer, Marquette Cement Manufacturing Co., Chicago, in which he covered three broad areas: preventive maintenance; maintenance training, and maintenance management. In discussing preventive maintenance, Hanks stressed the importance of the organizational aspects of a program and listed some of the considerations that will help make it effective. Taking up the matter of training, he reviewed several types of training programs which have been successful in maintenance organizations. He went on to discuss some of the records needed by foremen and supervisors and pointed out that these must be carefully maintained and evaluated in order to properly manage a maintenance program.

John G. Warner, plant manager, Chemstone Corp., Strasburg, Va., talking on the subject, "Maintenance at the Operation," said that most firms could reduce maintenance costs



When a piece of equipment was too large to bring to Cleveland, effective use was made of operating models

through stepped up efforts on the part of all levels of management. He contended that maintenance should be a "line," rather than a "staff" function and that the organization should be tailored around the particular operation, with proper consideration to its facilities and personnel. He added that maintenance performance should be evaluated in a similar manner to production performance. Pointing out that records are an important part of a preventive maintenance and cost cutting program, Warner said that they must be carefully reviewed by staff and line management in order to effectively serve their purpose of pointing up both present and future trouble spots. He described good housekeeping as the starting point of preventive maintenance and communications as the key to good teamwork.

"Cost Cutting Through Operations Research," was the subject of a talk by James L. Cox, manager of Minerals Operations at the Florida phosphate mines of International Minerals & Chemical Corp., Bartow, Fla. He discussed major operations research projects sponsored by his company from the viewpoint of an engineer and mining manager rather than an operations research professional. Tracing the development of these programs, he included significant statistics and gave examples of cost reductions which resulted from the studies. Cox described how the production departments actually put operations research techniques to work in order to realize maximum benefit from the data developed.

Discussing blasting vibrations in quarry operations, Daniel J. Miller Jr., chief engineer of Houdaille Construction Materials, Inc., Morristown, N. J., enumerated the various types of waves created by blasting operations at quarries. Miller described both earth waves and concussion in air, and observed that the latter is the greatest cause of neighborhood complaints. Tracing the impact of local zoning ordinances, growing pressure at the state level and the enactment of rules and regulations governing quarry blasting, Miller said his company decided to hire a consultant to help set up a program of proper blasting procedure. This program provided for careful recording of blast data, using seismograph machines, and detailed engineering for each blast. The company has developed information which proves that ground vibrations caused by its blasting are far below the energy ratio necessary to do physical damage. The actual problem, he said, is psychological rather than physical.

Miller went on to describe the effects of atmospheric conditions which may reflect an air blast back to ground level thus startling unsuspecting neighbors. In conclusion, he listed the procedures which his company has used to alleviate complaint problems in blasting.

The last talk on the "Cost Cutting" Session was presented by H. A. Corre, plant manager at the Bellefonte Operations of Warner Co., Bellefonte, Pa. Talking on "Control of Large Blasts to Tonnage Requirements," Corre introduced his subject by showing a short movie of a recent blast which broke enough stone for a full year's operations. He told how the Warner Co. determines the amount of stone to be shot by relating it to sales forecasts and inventory, and went on to describe the techniques used by the company's operating men. By shooting a single, carefully planned blast in a high face, the company has eliminated the need for smaller blasts, thus preventing interruption of production schedules during the operating season. Substantial savings and greater efficiency have resulted from increasing blast hole size from 6 in. to 9 in., and increasing both burden and spacing from 18 ft to 30 ft. He included a complete account of the loading and detonating practices as well as a description of the types of blasting agents used.

COAL PREPARATION—EMPHASIS IS ON FINE COAL

C. K. Tieche, vice president, Coal Preparation, Clinchfield Coal Co., Dante, Va., presided at the first of two sessions on Coal Preparation, Wednesday afternoon. William L. Crentz, assistant to chief, Division of Bituminous Coal, U.S. Bureau of Mines, Washington, D. C., assisted as vice chairman.

In speaking on the "Effect of Continuous Mining Equipment on Cleaning Plant Performance," W. H. Noone, superintendent of preparation, Semet-Solvay Division, Allied Chemical Corp., Montgomery, W. Va., discussed some of the points that should be considered from the preparation angle when a change to continuous mining is contemplated. He said that it is hard to categorize the effect of continuous mining on coal preparation as it will depend largely on a company's present system of mining. The greatest cost may be a loss in efficiency in making the required ash in the slack sizes. In studying the possible effect on coal preparation of a change to continuous mining equipment, the following information should be considered:

1. Complete size and gravity fractionation of section being tested while running present equipment.

2. Complete size and gravity fractionation of the section being tested while running proposed continuous mining equipment.

3. A comparing of size analysis to evaluate the effect on fine coal and water clarification capacity.

4. A plot of projected washer results from distribution functions to compare efficiency at various ash contents that may be desired, now or in the future.

5. A columnar section analysis of the area compared with an -Ash, -reject and -midcoal map of reserves.

Consideration of these points will give an accurate projection of whether continuous mining will affect preparation costs markedly or adversely, and indicate whether preparation equipment will have to be added or replaced.

"Fine Coal Cleaning with Heavy Medium Cyclones" was discussed by by William Benzon, superintendent of preparation, Bethlehem Mines Corp., Johnstown, Pa. In 1959 Bethlehem Mines made the first installation in the United States of the Dutch State Mines Heavy Medium Cyclone System for cleaning fine coal. Bethlehem chose heavy medium cyclones because it became desirable to wash fine coal at low specific gravities—as low as 1.35. At the present time normal washing gravity in the cyclones is 1.46. Separations have been made at as low as 1.31 specific gravity. During a five-week period when the plant was operated to make a separation of 1.46, the average ash content of the clean coal was 5.5 percent with a range of 4.9 percent to 6.2 percent. The air jig replaced by the cyclones had been producing a clean coal with an ash content of from nine to ten percent.

During 15 months of operation the heavy medium plant has handled 208,000 tons of raw coal. Only partial data on equipment life has been developed. It is anticipated that the present cyclones, when worn out, will cost 1.1 cents per ton of coal handled. However, the present segmented cyclones will be replaced by cyclones which do not have flanged joints, and their life is expected to be four times as great.

The Benzon paper was discussed by Dr. C. Krijgsman, Head, Coal Preparation Division, Dutch State Mines, The Netherlands. He said that of all the 55 Dutch State Mine Cyclone washer installations now in operation, or under construction all over the

world, most are handling coal under ½-in. in size. However, very good results have been obtained from some cyclone plants handling larger sizes—up to 1½-in. For example, a 92-tph cyclone plant in Rhodesia is handling 1¼-in. by 35-m coal in two 20-in. cyclones with accurate results. He also said that Dutch State Mines has figures which show a cut point for ½-in. by 35-m product at a 1.48 specific gravity and for plus ½-in. product at a 1.49 specific gravity—the probable error being 0.017 and 0.011 respectively.

Roger D. Curfman, fuel agent, the Cleveland Electric Illuminating Co., Cleveland, Ohio, said that, "The electric power industries are rapidly approaching a complementary marketing condition where the major portion of the output of one is the major source of supply to the other," in his paper on the "Slack Coal Problem." A full text of Curfman's remarks appears as an article in the May Issue of *Mining Congress Journal* beginning on page 34.

"Recent Progress in Thermal Drying of Ultra Fine Coal," was described by Raymond E. Zimmerman, vice president, The Paul Weir Co., Chicago. He pointed out that an increasing problem is presenting itself in this country in the need for drying coal in the minus ½-mm or the 20-mesh range. This has been brought about by the rapid spread of froth flotation. He went on to describe a fine coal drying plant in Turkey which is handling as much as 120 to 150 tph of minus ½-mm coal—a froth flotation product. The filter cake contains from 20 to 30 percent surface moisture which is reduced to 5–6 percent in a Buttner dryer system. This is a German dryer which is quite similar to American "flash" dryers. Total heat consumed is 3,173,000 B.t.u. per ton of water evaporated.

A second Coal Preparation session was held Thursday morning, May 18. R. K. Bogert, Jr., president, Badger Coal Co., Philippi, W. Va., presided. R. L. Llewellyn, manager of preparation, Eastern Gas & Fuel Associates, Pittsburgh, Pa., served as vice-chairman.

Loy A. Updegraff, project engineer, Bituminous Coal Research Inc., Columbus, Ohio, described the latest developments in equipment for continuous analysis. He said that instruments for continuous analysis and automatic control are rapidly taking their place in the coal mining industry. In several cases they have proven their value in the production of a higher quality product from preparation plants, while at the same time increasing preparation efficiency without increased labor or maintenance costs. Instruments which can make and record analysis continuously can also operate automatic controls when the proper electric circuitry is integrated. The Dutch State Mines have developed an apparatus for determining and recording the ash content of coal by X-ray. Although this system has not been used in this country, it is now being introduced by the American Minchem Co. Nuclear instruments now being used in preparation plants are primarily density and level indicating gauges, but others for measuring bulk density, moisture content, bulk flow, ash and sulphur, either have been developed or are in the research and development stage. Bituminous Coal Research, Inc., has been cooperating in the development of a moisture measuring device which measures the capacitance of a moving stream of coal. The capacitance varies with the moisture content of the coal. Updegraff concluded by saying automatic measuring and analyzing instruments, together with automatic controls, will be more widely used by the coal industry as time goes on and the need for increased automation becomes more apparent.

A number of materials presently being used by the coal industry to replace standard products in coal preparation plants, with resulting longer life and lower costs, were described by V. D. Hanson, mechanical engineer, Consolidation Coal Co., Library, Pa. Linear polyethylene is making an entry into the coal industry as replacement for steel because of its total resistance to corrosion by acids which are present when coal is conveyed in mixture with water. These linear polyethylenes costs less than stainless steel, and experience has shown they are as tough as their steel counterparts in resisting abrasion by fine coal. Hanson said Teflon, a fluorcarbon resin, is being used as chute lining and seal material because of its extremely low coefficient of friction and good mechanical strength.

By using "TI Constructional Alloy," or similar steel, as much as 50 percent savings in weight of steel can be realized in plant construction. In rotary dumps, rock hoppers, and other types of bins where impact is a factor, heat treated TI should be considered, he said. Stainless steels have permitted the use of thinner screen plates with a definite improvement in separation without changing the hole size or feet tonnage with a metal life of five to ten times. The same life is

A lot of coal was "mined" during the week

true in chute linings, especially where the product is wet and/or fine, or corrosive.

The final speaker on coal preparation was Donald A. Dahlstrom, vice president and director, The Eimco Corp., Research & Development Center, Palatine, Ill., who discussed "Processing and Disposal of Coal Flotation Tailings." He described the types of continuous thickeners and filters that are being employed in the coal industry, flow sheets using this equipment and described the influence of plant beneficiation methods upon operating results. He used several full-scale examples to illustrate reasons for a specific equipment selection and operation for minimum cost and maximum flow sheet simplicity.

SAFETY

Woods G. Talman, assistant vice president-operations-coal, U. S. Steel Corp., Pittsburgh, Pa., presided at the session on Safety, Wednesday afternoon. George Trevorrow, safety director, Bituminous Coal Operators' Association, Washington, D. C., was vice chairman.

"Human Engineering in Safety" was the title of the paper presented by C. G. Evans, personnel manager, The North American Coal Corp., Cleveland, Ohio. He explained that the field of human engineering is concerned about the relationship of men and machines. The mining industry then is concerned about the ease of operation, safety of the men, work procedures, mining methods, even the arrangement of the machines as a group, and roof control for the different types of machines. The relationship between men and machines points out the need for research in all areas and constant improvement in men, methods and equipment. Industry, he said, needs:

1. **A better work simplification program**
2. **Improved machine design to assure better maneuverability**
3. **Improved machine design to assure better working conditions for the operator**
4. **More attention to mining plans**
5. **Exhaustive research in roof control for the protection of personnel and for higher mining efficiency.**

Evans also discussed another phase of human engineering—the proper selection of the right people for the right jobs. He briefly discussed North American Coal's approach to the problem of selecting people both above and below the level of general mine foremen. The theme of his paper is that while human engineering is not an exact science, it is possible to apply it towards improving conditions and in selecting people with the proper attitudes and abilities—thus increasing the safety factor in the mining industry.

The complete text of Evans' paper was carried in the May issue of *Mining Congress Journal.*

In 16 years Montcoal has reduced its accident frequency rate from 98.8 to 3.87, according to S. P. Carter, chief engineer, Armco Steel Corp., Montcoal, W. Va. In discussing the "Benefits of a Sound Safety Program," authored by C. O. Kane, manager-coal mines, Armco Steel Corp., he said that in the early days of Armco's coal mine safety program the safety engineers' duties consisted largely of inspection, criticism and reporting—without a display of sympathetic understanding of the foreman's problems or a suggested solution. This was a regrettable mistake, he said. Although some accidents were prevented, line supervisors looked on safety as an unwise deterrent, and the safety engineer as a "management detective."

Carter went on to say that the company's first progressive step was to clearly designate the duties of the safety engineer and his inspectors as being staff functions. Criticism by the safety staff was to be accompanied by a suggested remedy. The safety engineer was also given the assignment of stimulating the program through research, analysis, and coaching. Next, he said, the responsibility for accident prevention was clearly defined as that of the line supervisor. With this responsibility, his authority was also clearly defined.

Carter explained that a major step in the formulation of Armco's program was the compilation of a Supervisors' Safety Manual. This covers all phases of the mining operations—surface and underground. For effective application of the contents of the manual and for general coverage of the over-all program, intensive management training was required. This training has been spread out over several years, and the results have been most encouraging.

"Evaluation of Various Means of Fighting Machine Fires Underground" was the title of the next paper which was co-authored by Donald W. Mitchell, chief, Experimental Coal Mine; John Nagy, chief, Branch of Dust Explosions; and Edwin M. Murphy, chemical engineer, Experimental Coal Mine, U. S. Bureau of Mines, Bruceton, Pa. Mitchell, who presented the paper, told how the U. S. Bureau of Mines investigated the extinguishing agents and techniques for controlling a fire on a simulated machine in an underground mine passageway at its Experimental Coal Mine. Research, he said, shows that visibility in the fire area is a primary factor affecting control operations; considerably less time and less extinguishing agent are required if the fire can be seen and if the control agent can be applied directly onto the burning fuel. Associated with good visibility, he explained, is closeness of approach. The closer the attack can be made, the less time and quantity of agent are required for extinguishment. Approach to the fire and visibility will be hindered by smoke and hot gases backing up against the ventilating current. Use of a transverse brattice about two-thirds of the height of the entry or application of a liquid stream will aid in controlling the smoke. Liquid agents were most effective when applied as a fog; however, if the attack must be made from more than 20 ft, high expansion foam and the solid or aerated stream techniques are more practical. He emphasized that the extinguishing agents should be applied at the maximum rate consistent with the equipment and supplies available. Mitchell concluded that the seriousness of coal mine fires makes it vitally important that the fire control system at each mine be reviewed carefully, objectively, and often to assure that the best possible protection is provided and maintained.

Charles T. Holland, head, Mining Department, Virginia Polytechnic Institute, Blacksburg, Va., presented a keen analysis of "Design of Pillars for Overburden Support." For many years coal mine pillar design has been based upon what has been satisfactory in the past or what has worked elsewhere. This procedure has not always produced satisfactory results. During the past 15 or 20 years, considerable scientific and engineering data and a number of basic principles have been developed that should greatly improve pillar design techniques. These data and principles concern probable loads on pillars, stress distribution in pillars, strength of coal in pillars and bearing strength of roof and floor rock. Holland discussed these factors in some detail as they relate to coal mine pillar design.

Roy L. Dulaney, director of safety, Mountaineer Coal Co., Fairmont, W. Va., in discussing Holland's paper, covered pillar design in deep mines, with a comparison of pillar size and

mining methods in deep and shallow mines. He also pointed out the effect of cleavage planes on roof conditions in pillaring operations, and discussed floor failure and its relationship to pillar failure in squeezes.

NEW OPERATIONS

The session on New Operations was held Thursday morning, May 18, with Harry LaViers, Jr., executive vice president, South-East Coal Co., Inc., Irvine, Ky., serving as chairman.

"Orient No. 5" was the title of the first paper of the morning and was given by Thomas L. Garwood, chief engineer, Freeman Coal Mining Corp., West Frankfort, Ill. He said that Freeman's Orient Mine No. 5 is scheduled to produce 7500 tpd of clean coal on a two-shift basis, with a maintenance shift taking care of the repairs, lubrication and adjustment of the equipment. Should a demand be made for greater production, the company can draw on built-in extra capacity. He noted that modern mining is to be the key to the design of this new mine: automation as far as possible, concentration as far as practicable, processing as up-to-date as the future market indicates, and emphasis on holding manpower to a minimum.

In discussing the operation, Garwood explained that coal will be mined with twin-boring machines and carried out of the mining area via belts to an automatic loading station where it will be placed in 15-ton, 8-wheel mine cars for transportation to the bottom. It is planned to use two 20-ton locomotives in tandem to handle these trips. The shaft bottom is so arranged that the trip is turned around and backed onto the load-track, coupled automatically and moved by car-haul onto a rotary dump. Half of each load will pass into separate pockets making up alternate skip-loads of 15 tons in each of two loading chutes. The shaft bottom and the coal hoist are designed to operate automatically but in an emergency can be stopped by the dispatcher at the rotary dump.

The 3½ by 1¼-in. coal will be cleaned in dense medium cells and the smaller sizes tabled, according to Garwood. Dewatering and heat dryers will be employed to make the coal ready for loading.

Scheduled to go into production this fall, Garwood said, Orient Mine No. 5 has enough reserves to provide an expected life of better than 30 years.

The complete text of Garwood's paper was carried in the May issue of *Mining Congress Journal.*

Well-filled meeting rooms were indicative of intense interest in advances in mining technology

W. A. Endicott, general superintendent, Ayrshire Collieries Corp., Indianapolis, Ind., described the newest major underground mine in Indiana—the Thunderbird mine. It will produce some 1,300,000 tons of steam coal annually, all to be consumed by the new Breed Station, a 475,000-kw generating plant of Indiana and Michigan Electric Co.

Endicott pointed out that the Thunderbird property consists of a roughly rectangular area of 10,000 acres, approximately four miles on a side. There are three mineable seams on the property with an estimated 100,000,000 tons of recoverable coal. Present operation, he said, is confined to the No. 6 seam which ranges from 55 to 70 in. in thickness. The master plan for mining this seam is to divide the rectangular property area into four quadrants and develop each quadrant successively. Selection of the southeast quadrant as the first area to be mined was based on the proximity of an area suitable for development of a fresh water lake in the northwest corner of the quadrant.

Endicott explained that the underground mining plan is the standard midwest panel system with no pillar recovery. Estimated recovery following this plan is 55 percent of the coal in place. Entrance to this all a-c mine is gained through three slopes—the ROM belt manway, supply and air slopes. Originally the mine was to be entirely on off-track conventional a-c powered equipment. Subsequent roof conditions have caused the company to alter its original selection of equipment, and it is presently operating three continuous mining machines and two conventional sections. Each piece of equipment was selected only after weighing its comparative merits for both production and maintenance. High capacity was a desirable feature, but the ability to stand up under rugged conditions also weighed heavily.

"Segco No. 1 Mine" was the title of the next paper coauthored by James E. Brown, Jr., manager of coal mine operations, Southern Electric Generating Co. and G. C. Dyar, vice president-mining operations, Alabama By-Products Corp., Birmingham, Ala. Brown, who presented the paper, explained that Segco No. 1 mine was opened to supply 1,500,000 tons per year of low cost fuel to the new Wilsonville generating plant of Southern Electric Generating Co. The

mine is located in the Warrior Basin on the Alabama coal field in Walker County.

Employing a room and pillar system of mining, the mine operates two production shifts per day, with the third shift used for major maintenance, belt extension, rock dusting and other deadwork. Eight conventional sections produce 8667 tpd of raw coal in two shifts. Seam reject is 25 percent.

The 750-tph capacity preparation plant includes a Baum type jig, four dewatering screens, one belt conveyor, a drag settling tank, a thickener, and a railroad car hoist.

Of special interest to the audience was Brown's description of the mine's maintenance program. One extra section with complete complement of mining equipment is kept in readiness. When a section is idle for preventive maintenance or belt extension, a crew is sent to the extra section. Major underground maintenance and belt extension is done on a third shift. For the maintenance cycle one extra machine of each type was purchased. This allows complete shop overhaul of equipment when total operating hours, tonnage handled, and downtime indicate the necessity of reconditioning. All equipment is overhauled in the surface maintenance shop.

The final presentation of the session was a discussion of "Sunnyhill No. 9 Mine" by E. W. Pearson, mine superintendent, Peabody Coal Co., Moxahala, Ohio. It is an entirely new operation and future expectations production-wise run to about 2,000,000 tons per year.

Pearson said that in June 1960 the company broke ground for the new strip mine on the New York Central Railroad at a point near Moxahala, Ohio. The New York Central laid about five miles of mine track, a 370,000,000-gal water supply dam was constructed across the valley, and work began on the erection of the preparation plant. The plant itself was erected with full speed and the company was able to get into production during the last week of November 1960.

Pearson pointed out that the plant is equipped with a fluid bed dryer which will handle 480 tph of 1¼-in. by 28-mesh coal. Coal is conveyed to the plant by a 48-in. belt conveyor. A flight conveyor feeds two five-cell jigs and from the jigs the coal passes to a washed coal classifier. Beneath the plant there are four loading tracks and a yard having an empty capacity of 188 cars. Railroad car movement is controlled by a car pull operated by one man.

One of the outstanding features, Pearson said, is a 550-ft long, house conveyor that runs from the plant to the domestic coal yard. Four drop outs, each stockpiling about 1500 tons, allows the company to stock four sizes for sale to truckers. Domestic truck loading is accomplished with an eight-yd front-end loader capable of loading about 300 tph.

Stripping is accomplished with a 65-yd shovel and loading with a 7½-yd unit. Four 50-ton trucks handle the haulage.

CONTINUOUS MINING

The final technical session of the 1961 Coal Show was held Thursday afternoon and was devoted to Continuous Mining. N. T. Camicia, vice president-operations, Island Creek Coal Co., Holden, W. Va., presided. J. Allan Brookes, manager, Mather Collieries, Picklands Mather & Co., Mather, Pa., assisted as vice chairman.

Norman Yarborough, general manager, Harlan Fuel Co., Yancey, Ky., opened the session with a paper on continuous mining in thin seams. Harlan Fuel is using a Joy CU 42 miner in a 39-in. coal seam at its Elzo mine. The mine is operated at two shifts a day—maintenance work being carried on by the third shift. In operation seven months, the projected 300 tons of coal per unit shift has been obtained sporadically—the best performance to date has been 342 tons. Early difficulties in the machine—which is the first model of a new line to be put to work underground—have been largely eliminated. These troubles developed primarily in the closed hydraulic circuit. The company expects all the "bugs" to be out of the miner by mid-1961 and plans to purchase two more machines to put the Elzo Mine completely on continuous mining.

The Lee-Norse LCM-28 model continuous mining machine was described by J. L. Marshall, superintendent, Keystone Mine, Imperial Coal Corp., Clymer, Pa. The company is operating two LCM-28s in the lower Kittanning coal seam which is characterized in the area by an undulating bottom. Coal height runs from 17 to 34-in. and it is necessary that average 34-in. mine height be maintained for shuttle car clearance. This means the miners have to cut up to 17-in. of bottom rock. Even under these conditions, though, a six man crew has averaged 26.09 tons of clean coal per man shift over a three month period on development work. The company expects that under normal conditions—39-in. coal—productivity will rise to 350 tons of material per shift. The miners work three shifts a day—with preventive maintenance and lubrication being done during the first hour of each shift.

Arthur Towles, maintenance engineer, Bell & Zoller Coal Co., Johnston City, Ill., in a paper entitled "Maintenance of Continuous Mining Equipment" told how with the aid of equipment manufacturers and their field men, Bell & Zoller has made many changes on its continuous mining equipment to cut face down-time to a minimum. These changes, along with an educational program in the coordination of both production and maintenance, has allowed the company to attain a smoother operation which has doubled tonnage at the face in 3½ years. As each continuous mining machine is brought out for over-haul it is modified. All hydraulic lines have been replaced with pressed-on fittings, for instance, and filters have been taken out of the suction side of hydraulic pumps and placed on the high pressure side. Permanent magnets have been installed in all reservoir tanks to protect pumps. Towles said, "The hydraulic system on each miner has been set up to be used with inverted emulsions; however, until such time as the oil manufacturers have perfected a suitable product that will eliminate excessive wear to the pump, none will be used."

"Face Ventilation and Dust Control with Boring Type Continuous Mining Machines" was the subject of a paper by John S. Todhunter, general manager, Barnes & Tucker Co., Barnesboro, Pa. Todhunter described work that has been done by his company to improve face ventilation with boring type continuous machines. This work has resulted in the installation on the mining machines of a diffuser fan which develops 900 cfm of air under normal voltage conditions. Air is coursed to the front of the machine through a system of duct work. The installation of the auxiliary diffuser changes in no way the standard system of ventilation using line brattice. Dust is allayed with three water sprays located on the head. About 7½ gpm are required when the machine is operating at a capacity of three tons per minute. Looking ahead, Todhunter said that his company is looking for a higher capacity diffuser fan and is experimenting with fans running at speeds up to 6000 rpm.

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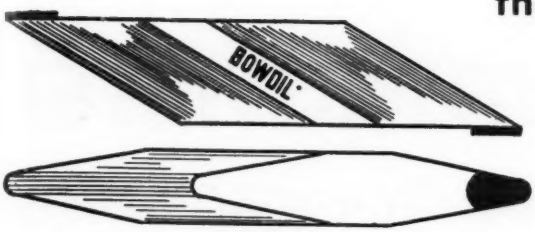

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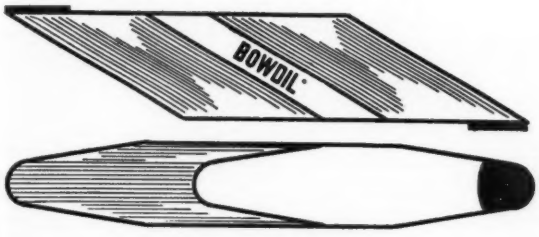

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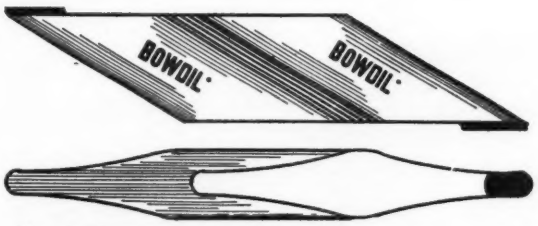

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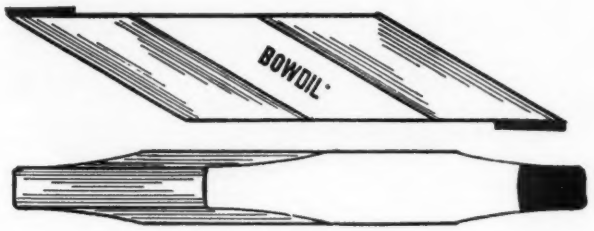

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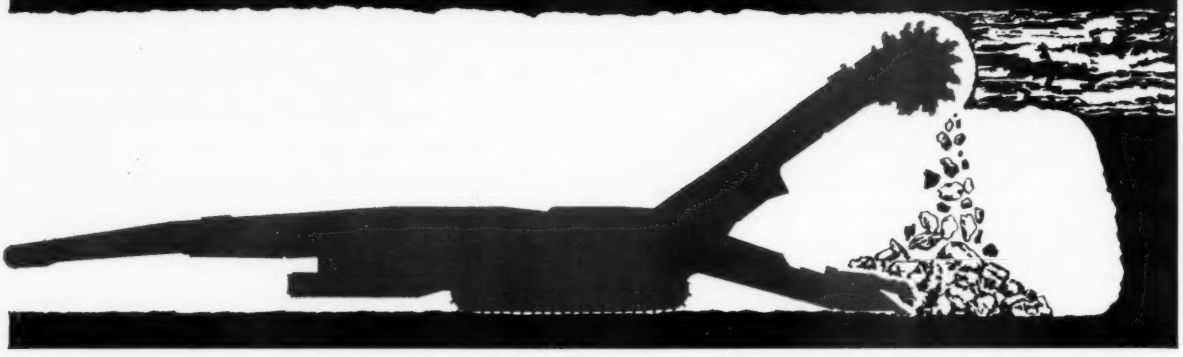

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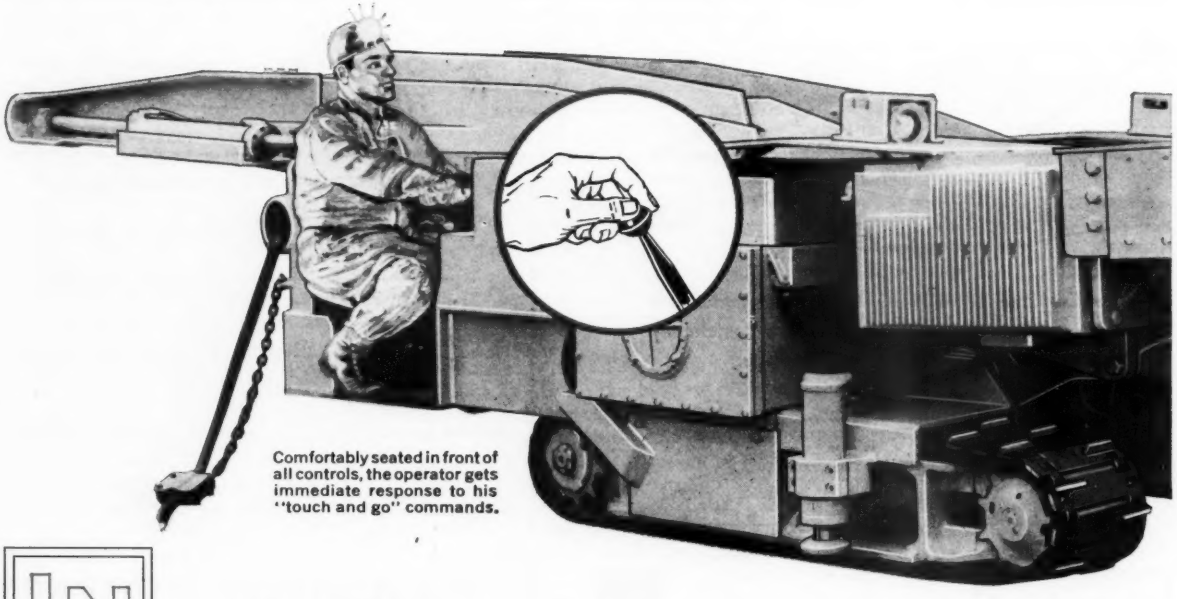

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"Sweeping" up the unwanted material, the Miner loads it separately into cars for haulage to the disposal area.

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"Touch and go" vertical control enables a hundred per cent extraction of high and low coal seams from 42 inches to 120 inches.

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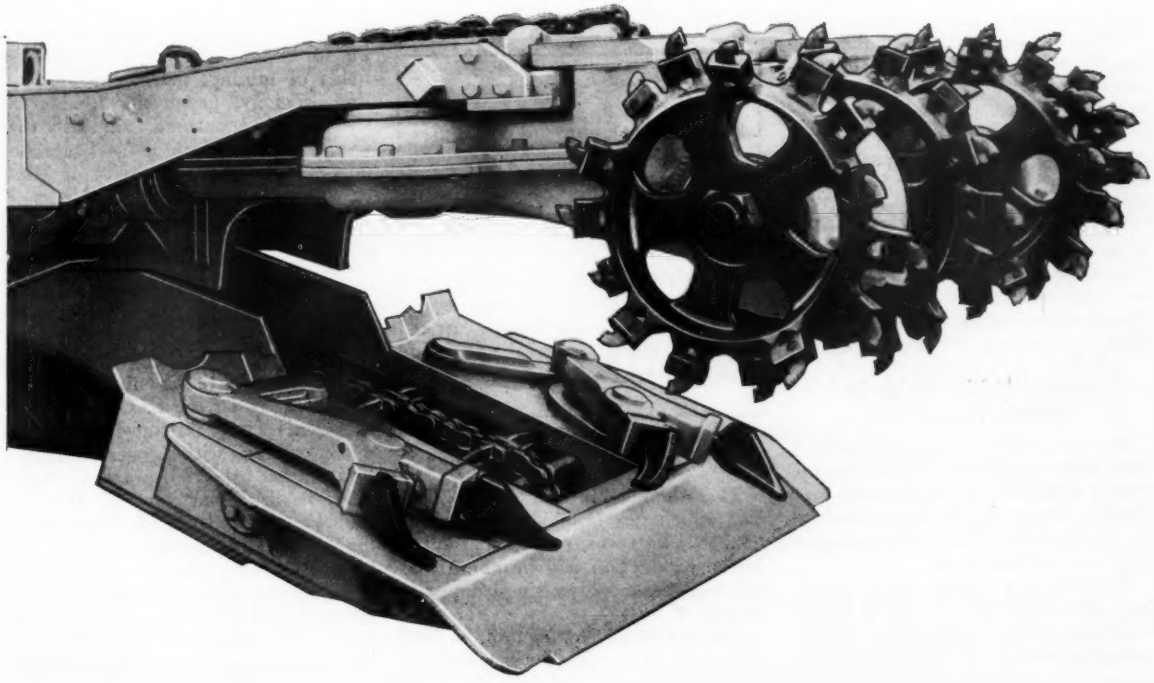

NEWS and views

New Procedures for Calculating Rock-Bolt Requirements

The U. S. Bureau of Mines has developed new procedures for calculating rock-bolt spacing to promote safe maintenance of mine roof.

According to a Bureau report recently released, the development resulted from a cooperative study of roof support problems in a Michigan copper mine. Although evolved to meet the problems of that particular mine, the method is said to be applicable "for most bolted roofs and for most mines."

First step of the new method is to overbolt—install many more bolts than are needed—as rooms of varying spans are mined. After each such room is mined out, the bolts are selectively removed, individually or in groups, by blasting the nuts off the bolts. Sag, strain, and bolt load are measured from outside the room, between removals. Computation based on these measurements show the spacing of rock bolts in relation to optimum roof span for any reasonable factor of safety.

Details of the method and mathematical and mechanical aspects of its application are given in Bureau of Mines Report of Investigation 5746 "Determining the In-Place Support of Mine Roof with Rock Bolts, White Pine Copper Mine, Mich.," which can be obtained from the Publications-Distribution Section, Bureau of Mines, 4800 Forbes Ave., Pittsburgh 13, Pa.

$6,000,000 Zinc Project in Tennessee Announced

An agreement to mine and mill at least 20,000,000 tons of zinc-bearing ores in a $6,000,000 project near New Market, Tenn., has been announced by Tri-State Zinc, Inc., and American Zinc Co. of Tennessee.

Tri-State is a wholly-owned subsidiary of Gold Fields Mining & Industrial Ltd., which, in turn, is a wholly-owned subsidiary of the Consolidated Gold Fields of South Africa, Ltd. American Zinc Co. of Tennessee is a subsidiary of American Zinc, Lead & Smelting Co.

Under the joint venture agreement, Tri-State will mine and mill ore deposits which are owned by American Zinc.

The agreement confirms a previous understanding which was reached in principle early in 1960 when Tri-State agreed to extend the drilling program carried out by American Zinc between 1954 and 1957, and, upon the successful completion of this program, to develop the mine and erect a treatment plant. It is expected that the treatment plant will have a capacity of 2800 tpd of ore by the summer of 1962 and this will ultimately be increased to 3600 tpd. While the mine is being developed and expanded, excess mill capacity will be utilized for milling ore from the nearby mines of American Zinc.

WANTED

Mining Congress Journal offers excellent opportunity to mining engineer with coal industry experience and ability to write. Position involves some travel.

Address inquiries to Editor. Include information on age, education, experience and marital status as well as a recent photograph.

Island Creek Reopens Algoma Mine

The Algoma mine at Algoma, W. Va., which has been idle since September 1960, was reopened May 8. Initial production will be about 900 tpd with the employment of approximately 50 men.

Island Creek's No. 17 mine at Red Jacket, W. Va., which was reopened May 1 at a production rate of 900 tpd, has increased its production schedule to over 3000 tpd.

Another Island Creek mine that will have an immediate increase in production is its No. 28 mine at Verunville, W. Va. The increase here will be about 800 tpd and will bring the mine to near its full productive capacity.

Management expressed confidence that near-term market developments would permit further increases in production at a number of Island Creek's other mines and the employment of additional men.

Fourth Annual Rock Mechanics Symposium Held

The Department of Mining of the Pennsylvania State University served as host to the Fourth Symposium on Rock Mechanics, held March 30 through April 1, at University Park, Pa. The symposium, an annual meeting for engineers and scientists in the fields of mining, petroleum production, geology, geophysics, and construction, is sponsored jointly by the Department of Mining at Colorado School of Mines, University of Minnesota, Missouri School of Mines & Metallurgy, and Penn State. Due in part to the cooperation of the National Science Foundation, it was possible to add an international flavor to the meeting with the presentation of papers by scientists from both Asia and Europe.

Starting with the opening remarks, presented by Dr. E. F. Osborn, vice president of research at Penn State, and concluding with a general summation offered by Dr. Howard L. Hartman, head, Department of Mining, The Pennsylvania State University, the Fourth Symposium included 24 papers covering the following areas of interest: strata movement from underground openings, behavior of rock under static and dynamic loading, stress measurement and ground

control, and dynamic loading in rock penetration.

Proceedings of the symposium are being published as Bulletin 76 of the Mineral Industries Experiment Station at Penn State and may be ordered from them after August 1 for $5.00 per copy.

Anaconda Discovers New Ore Deposit in Chile

The Chile Exploration Co., a subsidiary of the Anaconda Co., has discovered a sizable new copper oxide ore deposit, averaging about one percent, near its Chuquicamata copper operations in Chile. This new deposit will prolong the life of the oxide treatment plant at Chuquicamata if studies now under way indicate that the deposit can be mined and treated economically.

Chile Exploration is also studying expansion of the sulphide concentrating plant at Chuquicamata to treat larger tonnages of sulphide ore as the oxide ores in the pit are gradually exhausted, and is considering plans for building an electrolytic copper refinery at the Chilean port of Chañaral. About 75 percent of this refinery capacity would be for processing concentrates from Anaconda's El Salvador mine, with the remaining 25 percent used to refine production from other Chilean mines.

Newsmen Tour Coal Mines

A group of newspaper and magazine writers, accompanied by mine, railroad and electric utility officials as well as members of Congress and Government officials, recently toured mines, shipping facilities and electric power plants in a three-day trip through Virginia and West Virginia. The tour was sponsored by National Coal Policy Conference, Inc., which represents the mining and interrelated industries, to bring the nation's editors and writers a clearer understanding of the crucial role played by coal in the energy requirements of the country as well as of the efforts being made by the industry to meet this responsibility.

An example of the close integration of the coal mining, transportation and electric utility industries was seen when the group visited the $160,000,000 complex in Dickenson and Russell Counties, Va., put together by the Appalachian Power Co., Norfolk & Western Railway Co., and Clinchfield Coal Co., a division of the Pittston Co. Appalachian Power built a coal fired generating plant at Carbo, Va., which when completed by the end of this year will cost a total of $90,000,000. Clinchfield built its Moss No. 3 mine, at a cost of $40,000,000, to supply coal for the power plant, as well as for other customers in the metallurgical market, and Norfolk & Western invested another $30,000,000 in building rail facilities, including a $6,000,000 mountain tunnel, to move the coal from the mine to Clinchfield's large cleaning and preparation plant and then on to the Appalachian plant, about seven miles distant, and to other markets throughout the nation.

Other properties visited included Island Creek Coal Co. and the Amherst Coal Co., both near Logan, W. Va. Forty-five percent of all the coal mined in the U. S. is produced within 125 miles of Logan.

The newsmen also saw the making of coke from high grade metallurgical coal when they visited Stonega Coal & Coke Co. near Norton, Va.

On the final day of the trip the group toured the ship loading facilities of the Chesapeake & Ohio and the

(Continued on page 90)

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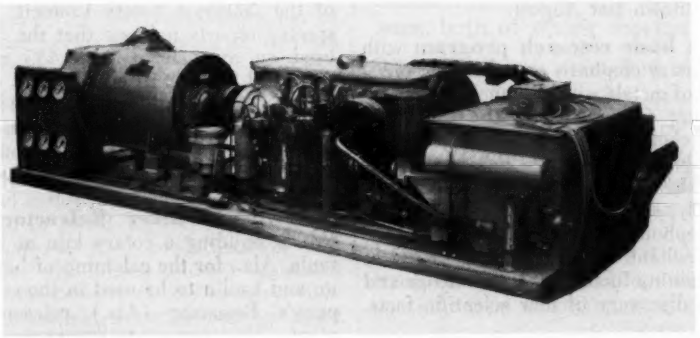

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(*continued from previous page*)

Norfolk & Western railroads at Newport News and Norfolk, Va. Both companies are expanding and further modernizing their dock facilities and, when completed, will be able to handle approximately 60,000,000 tons of coal a year for coastal and overseas shipments.

ALSO . . .

Medusa Portland Cement Co. plans to raze its idle Bay Bridge mill in Sandusky, Ohio, although its large 250,000 bbl silo and warehousing plant will continue to operate. According to company officials, the mill has been closed since September 30, 1960, because the marl deposit supplying the mill had been mined out.

The American Smelting & Refining Co. has announced tentative plans for liquidation of property in Cherokee County, Kan., including holdings at Crestline and an area southwest of Baxter Springs. Plans also call for disposal of property in Newton County, Mo.

The R. & F. Coal Co. recently purchased the old Sterling Smokeless Coal Co. mine at Whitby, W. Va., and put it back into production. The mine, under its original ownership, was shutdown last August.

A basic research program with primary emphasis on solid state physics of metals will be launched by Kennecott Copper Corp. Dr. Ewan W. Fletcher of Massachusetts Institute of Technology has been named director of the program, and Dr. Mervin J. Kelly, formerly director of the Bell Telephone Laboratories, will act as consultant. This program is aimed at obtaining fundamental knowledge and the discovery of new scientific facts.

Commercial production of nine high purity metals—antimony, arsenic, bismuth, cadmium, gold, indium, selenium, silver and tellurium—has been announced by American Smelting & Refining Co. Asarco is using a complex series of processes to produce metal of better than 99.999 percent purity. These metals will be available as "off-the-shelf" items. Previously they have been largely laboratory items.

Five hundred sixty-four active bituminous coal mines practiced systematic roof bolting as a method of roof control during 1960, an increase of 34 over 1959, according to the April 1961 issue of *Safety Newsletter* of the National Safety Council. Inspector reports indicate that the 564 used an average of 2,905,435 new bolts and 232,008 reclaimed bolts per month for a monthly total of 3,137,443 bolts. Approximately 57 percent of the estimated total underground mining was done under bolted roofs.

Harbison-Walker Refractories Co. is building a rotary kiln at Eufaula, Ala., for the calcining of bauxite and kaolin to be used in the company's Bessemer (Ala.) refractory plant. The company spent several years exploring and developing raw material sources in Alabama before deciding to build the kiln, which is scheduled to go into operation sometime this summer. The plant was designed by company engineers and is being built by the mining department.

A team of mining specialists from Paul Weir Co., Inc., has arrived in South Vietnam to assist the Vietnamese government in the development of the Nong Son coal mines. Harold L. Price, former superintendent of operations for Glen

Alden Coal Co., heads the team. The project is sponsored by the U. S. International Cooperation Administration as part of its technical aid program.

The Lake Superior Mines Safety Council held its 37th Annual Mine Safety Conference at Duluth, Minn., May 25–26. Working closely with the Duluth branch of the Bureau of Mines, the executive committee prepared a splendid program which included a talk on "Management's Viewpoint of Safety," by R. J. Linney, president, Reserve Mining Co., and a "Review of Disabling Injuries in the Lake Superior District—1960," by R. F. Wilson, manager of safety and compensation, Oliver Iron Mining Division, U. S. Steel Corp.

Site of the 1961 National First Aid and Mine Rescue Contest has been changed from Pittsburgh, Pa., to Charleston, W. Va., because of uncertainty in the construction schedule on Pittsburgh's new auditorium. The contest will be held in Charleston's new Civic Center on October 2, 3 and 4, and the headquarters hotel will be the Daniel Boone.

Marquette Cement Mfg. Co. in 1961 will spend several million dollars for large scale plant modernization, replacements and improvements. Among the company's major projects this year will be a complete rebuilding of the Catskill, N. Y., plant on the Hudson River. Work also will begin on an $18,000,000 rebuilding program at the Neville Island plant on the Ohio River at Pittsburgh.

Five to six billion dollars may be spent this year by all countries in the world-wide competition to keep pace or to gain a place in iron and steel making. Domestic steel producers plan to spend 1.2 billion dollars for expansion and modernization this year—the largest amount scheduled by the industry in any country. Russia's estimated outlay will be about one billion dollars, the same as last year.

Directors of Diamond Alkali Co. have approved "in principle" an agreement to merge with Bessemer Limestone & Cement Co. of Youngstown, Ohio. Approval of stockholders will be sought as soon as possible after definitive terms of the merger have been completed.

Eagle-Picher Co. is moving its plant at Miami, Okla., which processes rare metals, to Quapaw, about ten miles north of Miami.

MINE-POWER

by Steve Bunish

whose many years of practical experience underground followed by developmental work at Anaconda has made him a recognized authority on mining cables.

Steve Bunish answers your questions on mine cable application and maintenance.

#1: premature failure of trailing cables

Dear Steve,

We take all the routine precautions with our trailing cables—keep them off sharp edges, try to avoid overloading them—but the cable doesn't hold up as long as it should. Our only clue to these failures is little knots that show up in the jacket, but the cable doesn't fail until some time after these bumps appear. What are we doing wrong?

R.T.M., West Virginia

Dear R.T.M.

It sounds as if your cables are failing through excessive tension. Stretching a cable and then releasing it creates two different problems, both of which shorten cable service life.

When a cable is stretched, the conductors, insulation, and jacket are damaged. The stranded conductor is subjected to compression and shear forces, which weaken it. The insulation becomes very vulnerable to compression cutting, especially when the tight cable is run over and the insulation crushed against the stranded conductor. The jacket is also easier to tear and cut when the cable is stretched.

Release the tension on a stretched cable, and you set up different problems. The jacket and insulation are more elastic than the conductors, so they tend to go back to their original "pre-stretch" length. But once the conductor is stretched, it stays that way. Result: the jacket and insulation pull the conductor into kinks, which show up as bumps or knots in the jacket. These kinked spots won't necessarily break right away, but they're potential trouble spots that will fail pretty soon.

The only way to get around this problem is simply not to stretch the cable. Once the bumps appear, the damage is already done, and it's quite a price to pay for temporarily getting a few extra inches of reach out of a cable.

Steve Bunish will be glad to answer your minepower problem. Simply write it up and send it to "Minepower," c/o Steve Bunish, Anaconda Wire and Cable Company, 25 Broadway, New York 4, N. Y.

61254

See the man from ANACONDA® for Mining Cables

SIZE CONSIST

judged most important coal property for combustion performance

COAL PROPERTIES SIGNIFICANCE CHART FOR COMBUSTION PERFORMANCE

	STOKERS					
	S.R.	M.R.	T.G.	S.S.	P.F.	Cyclone
1. Size consist (as fired)	V	I	I	V	V[1]	V
2. Moisture[2]	M	M	N	M	V	M
3. Caking Index[3]	I	I	V	M	N	N
4. Ash Fusibility	I	I	M	M	I	V
5. Grindability	N	N	N	N	V	N
6. Friability	M	M	M	M	N	N
7. Volatile Matter	M	M	M	M	I	M
8. Fixed Carbon	N	N	N	N	M	N
9. Ash Content	M	M	M	M	M	M
10. Calorific Value	N	N	N	N	N	N
11. Ash Viscosity	M	M	M	M	I	V
12. Ash Composition	—See Footnote 4—					

FOOTNOTES:

[1] Degree of fineness is a better term for P.F.

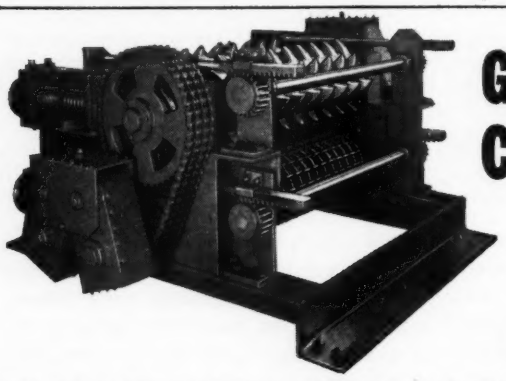
[2] Surface moisture is more critical than inherent moisture. Moisture is very important from the standpoint of plant flowability.

[3] Some engineers are attempting to use the F.S.I. as an index of the degree of caking.

[4] Ash composition is very important as it affects fireside fowling, but not important to combustion.

RATING CODE:

V — Very important
I — Important
M — Minor importance
N — Little or no importance



GUNDLACH CRUSHERS provide greatest uniformity of SIZE CONSIST

Coal Utilization, in a survey, asked power plant operators to rate thirteen properties of coal as being very important, important, of minor importance, or of little importance. The plants participating were fired by single or multiple retort underfeeds, travelling or chain grates, spreaders, pulverized fines or cyclones.

Without exception the operators of every type of firing device rated size consist as very important or important. No other coal property even approached size consist in importance in their opinion.

Let a Gundlach Crusher prove to you through a crushing and screening test at your mine that it provides the greatest uniformity of size consist. Your customer benefits by control of top size . . . less fines . . . less unburnt coal in ashes . . . more BTU output per ton . . . lower ash handling costs . . . greater overall utilization.

T. J. GUNDLACH MACHINE CO.

P. O. BOX 283 • BELLEVILLE, ILL.

Division of J. M. J. Industries

A $9,400,000 capital improvement program for 1961, a record for a one-year period, is under way in the coal division of Eastern Gas & Fuel Associates. Expenditures for the current year include: (1) completion of a major new coal cleaning and preparation plant at Federal No. 1 mine near Fairmont, W. Va.; (2) addition to cleaning facilities at the Keystone mine, Keystone, W. Va.; and (3) normal replacements and extensions, including mine cars and other equipment. The new Keystone facilities are scheduled for completion this year and the Federal plant early in 1962.

Freeport Sulphur Co. recently announced the completion of the largest shipment of liquid sulphur via ocean-going vessel in the history of the industry. A record 16,100 long tons of molten sulphur was transported by the vessel *Louisiana Sulphur* from Port Sulphur, La., to Tampa, Fla. The trip marked the inauguration of the coastwise tanker service which is part of a new $23,000,000 program to move the company's sulphur in liquid form—rather than the traditional solid lump form—into major market areas for storage and transhipment to its customers.

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 (Continued from page 72)

SUBCOMMITTEE WILL STUDY IRON ORE RESEARCH

Conditions in the domestic iron ore industry will be aired at a public hearing June 22 by the Senate Interior Subcommittee on Minerals, Materials and Fuels, Chairman Carroll (Dem., Colo.) has announced.

The Subcommittee will not have any specific bill before it, Carroll stated. The hearing will afford an opportunity for Government and industry witnesses to suggest possible methods of accelerating and expanding research on beneficiation of low-grade iron ore deposits other than taconite in the Lake Superior District and other areas of the country.

ENV . . .

Republic Steel Corp. plans to move substantial tonnage of Liberian iron ore to Cleveland through the St. Lawrence Seaway this season. Previously this ore has been unloaded at Baltimore and transferred to rail cars for delivery to Republic plants. If plans are completed, ocean ships of 21,000-ton capacity would bring the ore from Africa's west coast across the Atlantic, up the East Coast and through the Gulf of St. Lawrence to Countrecouer, Quebec, near Montreal. Here it would be transferred to smaller vessels of 3000 to 9000-ton capacity for the trip through the Seaway to Cleveland.

The Tennessee Valley Authority has announced it is buying 10,000,000 tons of raw coal from West Kentucky Coal Co., in the next ten years. The contract calls for TVA to buy 1,000,000 tons a year for the duration of the contract for about $29,000,000. The coal is destined for TVA's plant at Gallatin, Tenn.

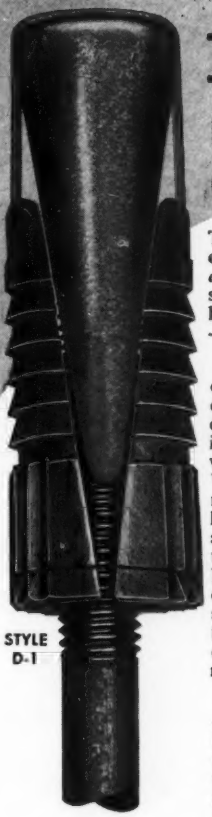
The new multi-million dollar Bestwall Gypsum Co. plant near Blue Rapids, Kan., has gone into production. It will be fed by the oldest active gypsum mine west of the Mississippi, the Bestwall mine, which contains gypsum rock with a purity rating of upwards of 99 percent.

Secretary of the Interior Stewart L. Udall, with a party including representatives of the Government, the railroads and coal industry, recently visited West Virginia coal mine properties and described his tour as "exciting . . . profitable . . . sobering and enlightening." He paid tribute to the coal industry for its productive efficiency and management-labor cooperation and said that nothing would please him and President Kennedy more than to have coal regain the position it once held as a supplier of energy for the Nation. Questioned about his recent decision to increase residual oil import quotas, Udall said he would run a "tighter administration" on residual oil and he thought "coal people are going to be pleased with what we do."

Magnet Cove Barium, a subsidiary of Dresser Industries, has installed a 125-ton beneficiation plant to recover valuable metals at its barite mine in Walton, Nova Scotia. Last year, the company confirmed discovery of a deposit of lead and silver ore in its barite mine.

By 1975 there will be 500,000 all-electric homes in the seven states served by American Electric Power Co., according to the company's annual report. In 1960 the AEP system added a record 6200 electrically heated homes to its lines, and now has a total of 25,800 buying "heat by wire."

Get DOUBLE EXPANSION for DEPENDABLE roof support with PATTIN roof bolts and expansion shells



The unique double expansion feature of all Pattin expansion shells insures *dependable* roof support, in hard or soft roof conditions. Their double holding power guards against failure — even under a 20 ton pull!

Pattin features include a parallel contact with the hole, and no definite drilling depth is required, as the shell can be securely anchored at any place in the hole. They anchor solidly and will not turn while being tightened. Wedge and shell are assembled in a manner to prevent loss of parts in handling, and the bolt and shell assembly are furnished as a complete unit. Plates are bundled separately. No special nuts or ears are required on the bolts. These features make a safer roof — and a safer roof means fewer accidents, increased production, more clearance for equipment operation and better ventilation.

Pattin specializes in roof bolting —it's our business, not just a sideline! Your business is important to us, and our service engineers are always available for consultation on your roof problems—ready to give you service when you need it! WRITE OR PHONE US TODAY for complete details.

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The PATTIN split-type BOLT

The split-type bolt is one of the first slotted bolts, and continues to be a favorite wherever split-type bolts are used. Many mines still prefer this type. The bolt is a full 1-inch in diameter, with cut threads and furnished with hex or square nuts and various size plates and wedges.

IN WESTERN STATES

Pattin expansion shells are available and serviced exclusively by Colorado Fuel and Iron Corporation, Denver, Colorado. Western mining companies should contact them direct for information and consultation.

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Meet Denis Plan the Hercules Technical Man who Pioneered the Introduction of Short-Period Delays in Southern Underground Coal Mining

It was back in early 1957 when Denis Plan, veteran Hercules technical representative, and several large mining operators conceived the idea of using Short-Period Delays in southern underground coal mines.

Extending over a period of several years, field trials in many underground mines in the southern coal fields proved that the use of Short-Period Delays resulted in:

Reduced vibration, concussion, and noise
Reduced damage to roof, ribs, and pillars
Produced more uniform fragmentation and less fines
Savings—fewer drill holes needed with reduction of explosives consumption
Quicker mining cycle
Safer operations—less exposure for shot-firer—less smoke and less disruption of ventilation

No Vent® Short-Period Delay Electric Blasting Caps are available in delay periods as recommended by the United States Bureau of Mines for coal mine blasting. Leg wires, with the most modern plastic insulation, are manufactured in a variety of lengths for all mining needs.

For complete information on how No Vent Short-Period Delay Electric Blasting Caps can be applied to your underground mining operation, call your Hercules representative or write direct to the office nearest you.

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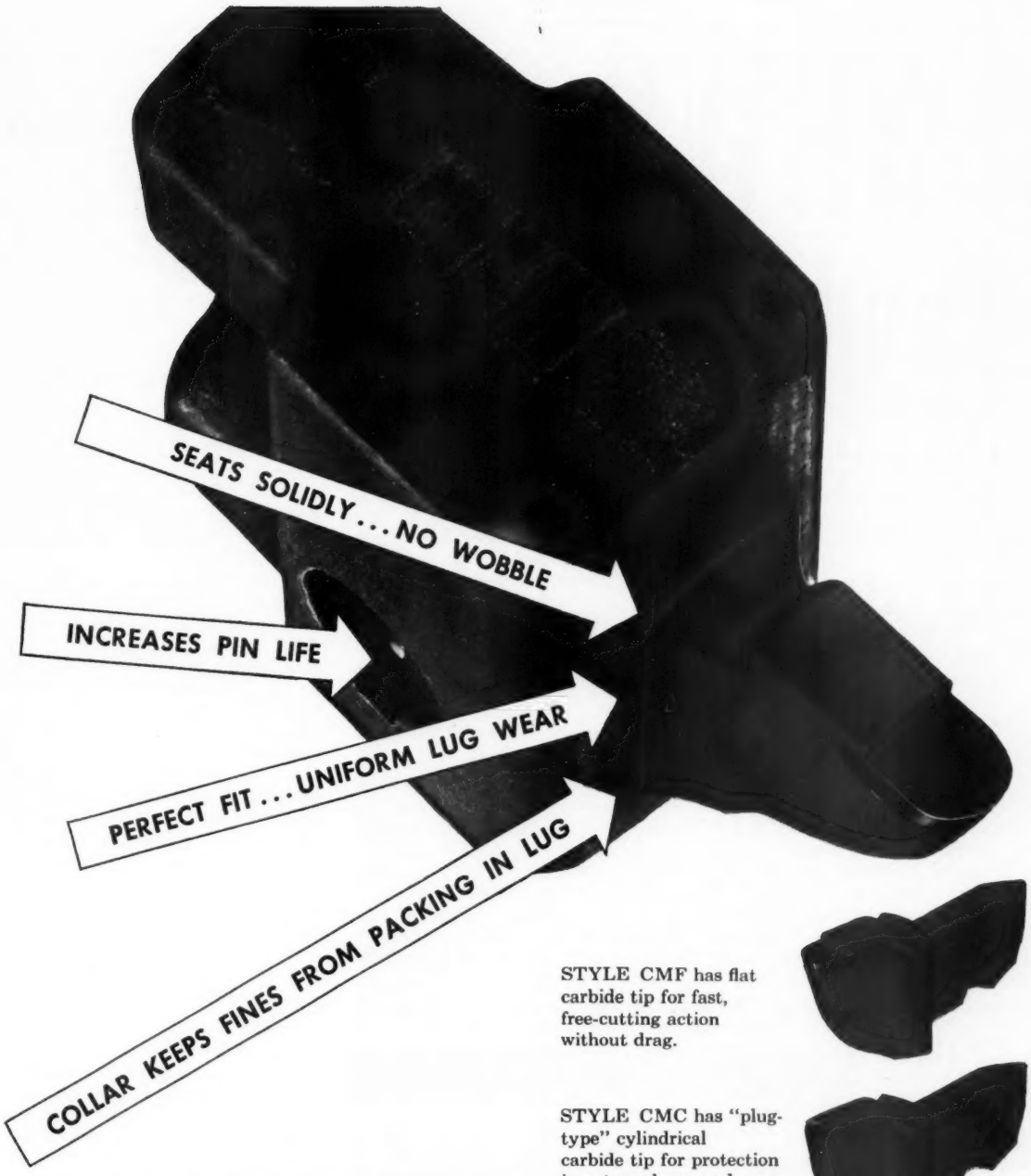

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NEWS and views

Western

Union Carbide Receives AEC Contract for Rifle and Uravan Mills

Union Carbide Corp., through its division Union Carbide Nuclear Co., and the Atomic Energy Commission have signed a contract for uranium concentrate purchases from the corporation's Rifle and Uravan, Colo., processing mills. The new contract extends through December 31, 1966, replacing a previous agreement, and provides that the Government will purchase concentrates with a total value of about $100,000,000. Up to 12,154,730 lb of U_3O_8 are deliverable to AEC between the April 1, 1961 effective date of the contract and its expiration.

Terms of the new contract also provide for deliveries of U_3O_8 produced from eligible independent ores. Effective April 1, Union Carbide may deliver 3,000,000 lb of U_3O_8 annually of which no more than 2,500,000 lb may be derived from company controlled ores. The company limitation may be reduced to 2,200,000 lb if sufficient ores from independent producers are offered. Only uranium concentrates will be purchased under the new agreement. AEC's first contract for procurement of concentrates from the old Rifle mill was executed in 1947. The first Uravan contract was signed in 1949.

American Metals Acquiring Interest in Canada Tungsten

American Metal Climax will invest $3,500,000 to acquire 35 percent interest in Canada Tungsten Mining Corp., Ltd., which plans to build a tungsten concentrator at its mine property at Flat River, North West Territories. Dome Mines Ltd. and Ventures Ltd. are also major participants in the project. The Canadian government will assist in construction of access roads to the mine site. The ore body, described as being a rich deposit, will be mined by open pit methods. Production should begin early in 1963.

In another development, American Metal announces that its former Mexican subsidiaries are now consolidated into a new company, Metalúrgica Mexicana Peñoles, S.A., which will be 51 percent owned by Mexican capital by virtue of an $8,000,000 investment in the company. Amax will own 49 percent of the equity in the new company. Metmex will continue mining, smelting and refining conducted by the former American Metal subsidiaries. Expansion plans include a zinc smelter at Torreón and sodium sulfate plant at Laguna del Rey where the new company has important mineral claims.

Interior Withdraws 5000 Acres from Oil and Gas Leasing

Nearly 5000 acres of high-grade potash deposits in southeast Utah have been temporarily withdrawn from oil and gas leasing by the Department of the Interior. The property is in the Seven Mile area of Grand County and is six miles from Cane Creek where Texas Gulf Sulphur Co. is developing a potash mine on a 9000-acre tract that was withdrawn from oil and gas leasing last August. The new withdrawal is for a ten-year period. Potash deposits in the Seven Mile area are from 3600 to 5000 ft deep. They reportedly contain one of the richest potash deposits in the United States, and were located through systematic drilling by private companies. Withdrawals of the lands from oil and gas leasing will make it possible for the Seven Mile area to be jointly developed with the Cane Creek deposits.

Bagdad Copper Corp. has lined a 264 by 114 by 7 ft deep reservoir at its Bagdad, Ariz., leaching plant with the largest sheet of polyvinyl plastic material ever fabricated in one piece for industrial use. The flexible plastic lining will hold up to 1,400,000 gal of acidic copper solution used in copper recovery operations at Bagdad. The lining, which is aluminum coated, was fabricated with electronically-welded seams and then accordian-folded in two directions for shipment in one crate to the plant from Long Beach, Calif. Installation time in the reservoir was about four hours. Edges are buried in the berm for firm anchorage. The vinyl lining is estimated to have lowered reservoir construction costs by about $24,000.

Effectiveness of Safety Glasses Program Proved

Employes in the Electrolytic and Melting departments of the Bunker Hill Company's Kellogg, Idaho, zinc plant experienced a 55.29 frequency rate of eye injuries in 1955. The next year the company started a safety glasses program and frequency fell to 21.48. During 1959, the company's last full operating year, the frequency dropped to 2.75. Bunker Hill intends to expand its safety glasses program to all surface plants.

New Concentrate Contract for Durango Mill

Vanadium Corp. of America and the Atomic Energy Commission have reached a new agreement for the purchase of uranium concentrates produced in the company's Durango, Colo., processing mill. The new agreement extends through the end of 1966, replacing a contract that would have expired next year.

Under the new contract, effective April 1, 1961, the Government will purchase a maximum of 2,306,000 lb of U_3O_8 in concentrates valued at about $18,500,000 and derived from VCA controlled mines. Purchases of uranium derived from treating eligible ores of independent producers is also provided for in the contract. Under terms of the contract, VCA can deliver 800,000 lb of U_3O_8 prior to April 1, 1962, and 750,000 lb annually thereafter. About 400,000 to 450,000 lb of U_3O_8 derived from company controlled ores are deliverable to the AEC with the balance coming from independent ores. After April 1 ,1962, the maximum annual deliveries can be increased if independent production exceeds 348,880 lb. For the four years ending June 30, 1960, 41 percent of the ore for the VCA mill was supplied by independent producers.

The AEC's first uranium purchase contract with VCA was signed 14 years ago and covered purchases from the company's Naturita, Colo., mill which discontinued operation in 1958. First contract for the Durango mill was signed in 1949.

ALSO . . .

Sherritt Gordon Mines Ltd. has purchased 3500 tons of nickel-cobalt calcines from the U. S. Government stockpile for about $700,000. The calcines, containing about 19 percent nickel and 13 percent cobalt, will be processed at the company's Fort Sas-

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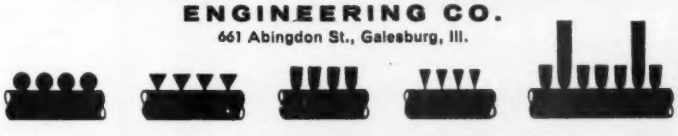

Bee-Zee Screens in a wide variety of shapes and sizes meet the needs of leading firms in the coal, minerals, quarry, oil, food, chemical, plastic, brewing, distilling, pulp and paper, rubber and other industries.

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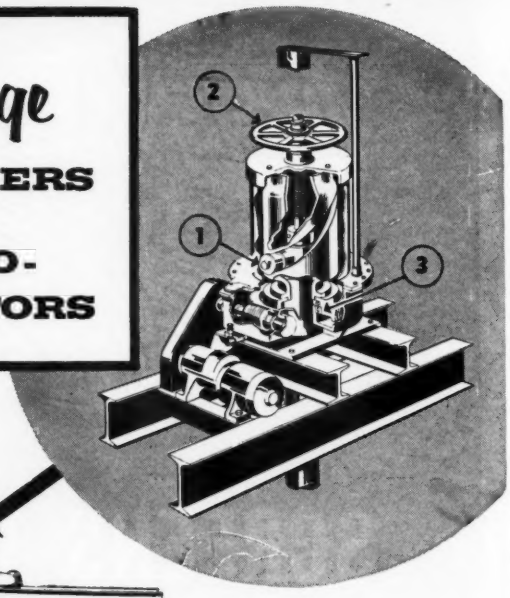
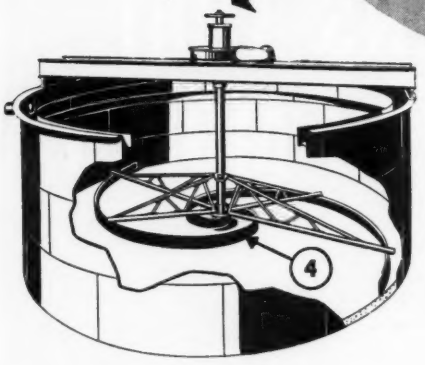
THICKENERS and HYDRO-SEPARATORS





1. "Auto-Raise" device.
2. Manual or power raise.
3. Replaceable ring-type ball bearing support.
4. Spiral rakes, and "froth rings."

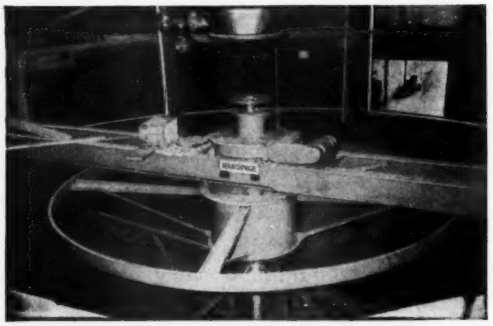
The higher the solids content in the thickener underflow, the lower the cost of filtering for subsequent processing or disposal.

The spiral rakes of the Hardinge Thickener compress the solids to maintain high density of underflow.

The "Auto - Raise" drive mechanism prevents overloading as the underflow is thickened.

Submerged parts may be supplied with rubber or lead covering or fabricated from wood or any metal available for structural parts.

Complete specifications upon request. Bulletin 31-D-52.



Also available are "froth rings" for froth-free overflow and superposed type tank construction (as shown above) for minimum floor space and building economy.

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katchewan, Alberta, refinery. Sherritt's interest in the calcines, which were declared in excess of national stockpile needs, stems from the company's development in powder rolling of cobalt strip, wire and rod.

Reactivation of 30 idle reduction cells at the Columbia Falls, Mont., reduction plant of Anaconda Aluminum Co. has brought the plant to 100 percent operating capacity. Since July 1959, the plant had been producing at 87½ percent of its 65,000 ton annual capacity. The decision to return to full capacity operations was made primarily to lower costs and so that the company can maintain its competitive position in the industry.

Cerro Corp. is investigating the feasibility of building a primary aluminum reduction plant in the Pacific Northwest with a capacity of 55,000 tons annually, to be served with power from the Bonneville Power Administration. The company has been consolidating its position in aluminum and has acquired United Pacific Aluminum Corp. of Los Angeles and participation in Alroll, Inc., of Oswego, N. Y. Part of the production from the proposed smelter would be shipped to United Pacific for conversion into enamelled sheet and strip coil. Before being acquired by Cerro, United Pacific had contemplated building a reduction plant in the Northwest and negotiated a contract for electricity from the Bonneville Power System.

Erection of a 200-tpd underground concentrator at the Mayflower lead-zinc mine is under consideration by New Park Mining Co. Tailings from the mill would be used as stope fill.

Controlling interest in an asbestos deposit in the San Joaquin Valley of California has been acquired by Hidden Splendor Mining Co. The company will evaluate the deposit with a view to mining it by open pit methods. Johns Manville Corp. and Union Carbide Corp. have asbestos interests in the area, which is in San Benito County.

An iron deposit near Redding, Calif., is being diamond drilled and investigated by Iron Exploration Co. The company represents an exploration venture between Bunker Hill Co., W. R. Grace & Co., Morrison-Knudsen, Inc., and Hydrocarbon Research, Inc.

Some 1,658,000 manhours have been worked by employes of the Utah

Copper Division refinery, Kennecott Copper Corp., without a lost time accident. The last disabling accident at the refinery occurred June 4, 1960.

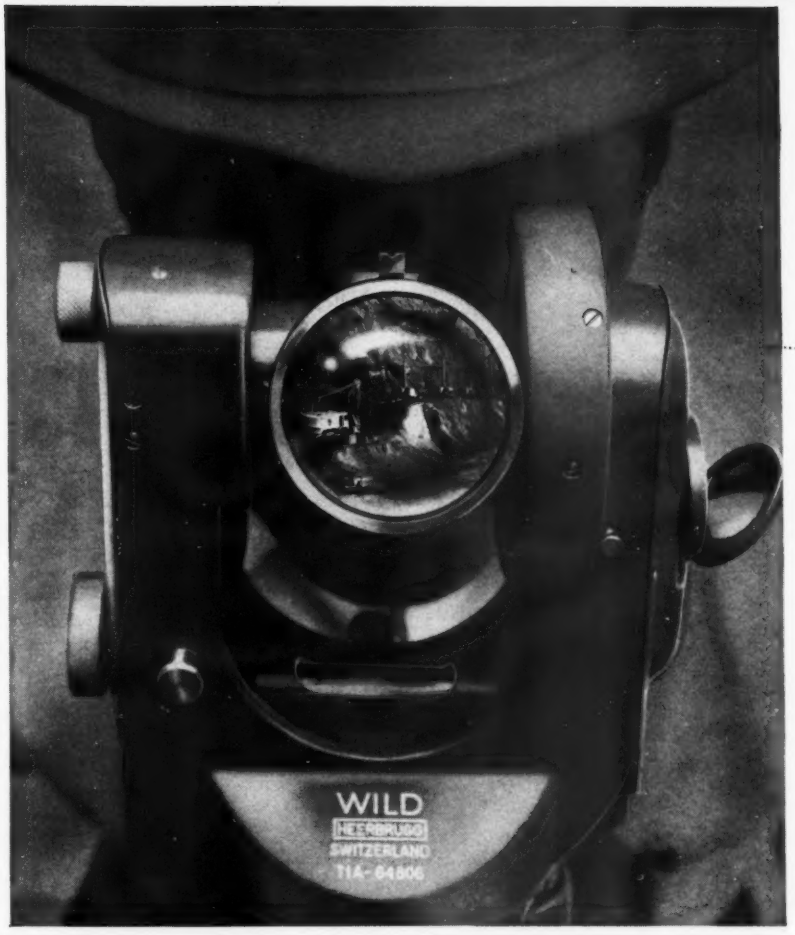
Big Horn Gypsum Co. has started operations at its Cody, Wyo., gypsum wallboard plant. Design capacity of the plant is 100,000,000 board feet per year. The company is exploiting nearby gypsum deposits by open pit methods.

An option has been taken on the Red Mountain molybdenum mine of Vanadium Corp. of America in Clear Creek County, Colo., by American Metal Climax, Inc. The mine operated during World War I and II and shut down in 1947. It is located at 11,000 ft. Exploratory drilling is planned.

Lignite deposits near Glenrock, Wyo., will be mined according to plans of American Humates, Inc. The company proposes a 200 to 300 tpd strip mining operation. Humic acid in the lignite will be used in the manufacture of fertilizers.

A new $15,000,000 expansion and modernization program is being undertaken by Colorado Fuel & Iron Corp. at its Pueblo, Colo., steel plant. New fabricating equipment and gas cleaning equipment for four blast furnaces will be installed and the company will build a new lime burning plant. Substantial quantities of burnt lime will be needed in the 100,000-ton per year oxygen steel-making plant now nearing completion.

"Cut it out Clancy, you know I can't stand people cracking their knuckles!"



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Yieldable Arches "give" to stabilize roof

Where conditions underground are unstable, Bethlehem's Yieldable Arch is often the best answer for dependable roof support. Utilizing the old technique of letting the enemy beat himself, the Arch yields gradually instead of steadfastly resisting, so that the overburden can settle into a natural arch of its own.

As long as pressures are excessive, the Yieldable Arch will continue to "give." As soon as stability is reached, the Arch holds the line.

A Yieldable Arch Set consists of curved U-shaped sections nested together and overlapped enough to permit clamping with husky U-bolt clamps. The clamps control the tightness in the joint, and permit yielding when the forces exceed the load for which the joint was intended. Each Arch set is connected to adjoining sets by means of horizontal struts, which add lateral rigidity to the structure.

Besides increasing mine safety, the Yieldable Arch offers high salvageability, and usually pays for itself within its first year of service. A Bethlehem engineer would like to discuss the Yieldable Arch with you. You can reach him through the nearest Bethlehem office.

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SEATTLE GETTING READY FOR 1961 Mining Convention

Organization of committees for the Seattle Convention of the American Mining Congress is now being completed, and the following have accepted key posts to serve with General Chairman Robert M. Hardy, Jr., president of Sunshine Mining Co. and Co-Chairman S. M. Strohecker, Jr., Seattle manager for E. I. duPont de Nemours & Co.

Welcoming: Chairman, M. H. Freedman, district vice president of sales for Columbia-Geneva Steel Division, U. S. Steel Corp.; Vice Chairmen, Ralph Winship of Columbia-Geneva Steel, and S. C. Bacon of Allis-Chalmers Manufacturing Co.

"Potlatch" Celebration: Co-Chairmen, Donald L. Anderson, associate professor, School of Mineral Engineering, University of Washington, and H. F. Yancey, president, West Coast Mineral Association.

Ladies: Honorary Chairman, Mrs. Dorothy Hardy of Yakima; Co-Chairmen, Mrs. Robert M. Hardy, Jr. of Spokane and Mrs. Woodfred E. Romig of Seattle; Hospitality, Mrs. Ralph Watson and Mrs. Kenneth H. Anderson; Tuesday Luncheon, Mrs. R. M. Olive and Mrs. Arthur J. Theis; Wednesday Brunch, Mrs. Harold L. Davidson and Mrs. Oren O. Langness; Hostesses, Mrs. Fred B. Brien, Mrs. Fred R. Young, and ladies of the Seattle and Tacoma Sections of WAIMME.

Trips: Chairman, Wylie M. Hemphill, president, Pacific Silica Co.—who will be assisted by John J. Eckhart, Northport Limestone Co.; Donald Meslang, Crucible Steel Co. of America; H. A. Hubbard, Chicago Pneumatic Tool Co., and B. R. Tarrant, Ingersoll-Rand Co.

Publicity: Chairman, David G. Wood, publications representative, Bethlehem Steel Co.

Additional committee members are being named, and an enthusiastic group of mining men and ladies will cooperate to assure a smooth running Convention and a warm welcome to the many mining visitors to Seattle and the Pacific Northwest.

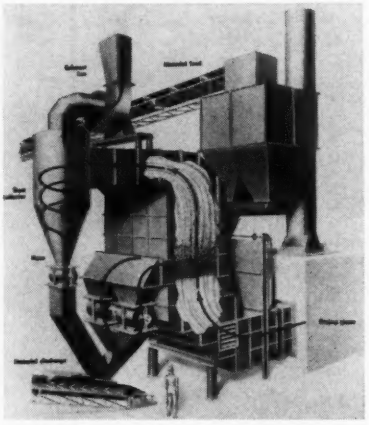
State and district chairmen of the Program Committee meet this month with National Chairman Joseph C. Kieffer, manager of American Smelting & Refining Company's Northwestern Mining Department, to arrange a hard-hitting program that will have wide appeal to mining men. Hundreds of suggestions have been received and will be given close attention by the Committee.

The Convention talks will cover vital subjects relating to both policy matters and operating problems, making it doubly important for mining men to be on hand come September. Sessions on national mineral policies, the state of the mineral industries, public lands policies, labor relations, management techniques, uranium, and gold, silver and monetary problems, are among those planned. The technical sessions, devoted to all phases of open pit and underground mining, milling and metallurgy, safety, exploration and geology, and general operating and maintenance problems, will cover a wide range of new developments.

The opportunity to learn what the industry is doing and how it can best meet the challenges ahead make the 1961 AMC Mining Convention a "must" for every mining man. If you haven't already made plans to be on hand, do it now. A large attendance is expected and requests for reservations should be sent in without delay. All hotel and motel reservations are being handled through the Housing Bureau, Seattle Convention and Tourist Bureau, 215 Columbia Street, Seattle 4, Wash.

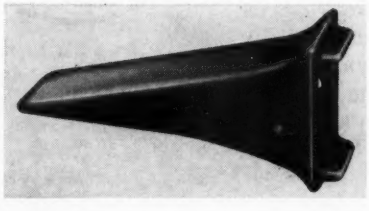
SEPTEMBER 10—13
TRIPS SEPTEMBER 14

manufacturers forum



A DRYER FOR PROCESSING GRANULAR SOLIDS—it can also be modified for use in cooling or roasting operations—has been announced by Link-Belt Co., Prudential Plaza, Chicago 1, Ill. Basically the Fluid-Flo dryer consists of a housing and a constriction plate over which material to be processed is fed by one or more feeders. Hot drying gases are pulled through the constriction plate, under fan-induced suction, causing the material to be suspended in a fluidized mass above the plate. The suspended mass acts like a fluid and flows horizontally across the plate to the discharge chute. The unit, with no moving parts, is low on maintenance, has a high thermal efficiency and processes materials continuously, according to the manufacturer.

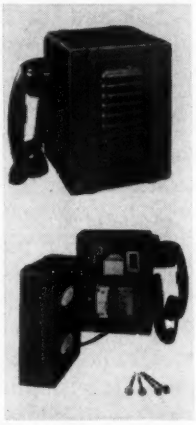
A NEW ALL-FORGED NICKEL ALLOY STEEL POINT has been introduced by the H&L Tooth Co., 1540 South Greenwood Ave. Montebello, Calif., for ripping rock and other hard compact material. Made of forged alloy steel, the tooth is heat treated to give maximum impact and abrasion resistance.



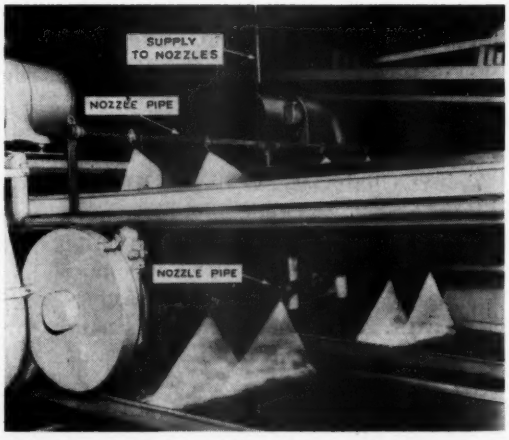
AN ALL PURPOSE HOOK which can be released while loaded has been introduced by Merrill Brothers, Artic St. Maspeth, N. Y. The releasing feature permits the operator to stand clear and eliminates hazards of unhooking live loads. A positive lock prevents opening under any load conditions except when intentionally released by the pull ring. The Release-A-Matic hook is said to combine quick use of conventional hook with safety of a shackle, without pin problems.

A LINE OF SOFT-FACED HAMMERS is being distributed by New Plastic Corp., 1026 N. Sycamore Ave., Los Angeles 38, Calif. The hammer is said to eliminate thread stripping, broken or loose handles, and heads flying off. The hammer holder consists of a unidirectional fiber glass handle, fitted with a durable linear polyethylene grip, and epoxy bonded to the non-sparking hammer head. It is available in 28 hammer sizes from 4 oz to 20 lb with interchangeable and replaceable faces in a full range of hardnesses.

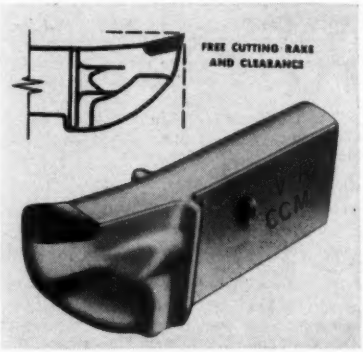
A TRANSITORIZED COMMUNICATION UNIT that utilizes existing interplant or mine telephone lines, the M-S-A Pager, is available from Mine Safety Appliances Co., Pittsburgh, Pa. The unit is self-contained and has two primary functions—to call or page over a loud speaker and to communicate semi-privately by telephone. It is individually powered by two dry cell batteries, employed only when the Pager is in use. The transistors have no filaments and are vibration proof. A two-conductor wire connects Pagers to each other, and to existing telephone lines. Ten or more units can be installed on a single line. It can be transformed into a telephone by a lift of the handset.



AN AUTOMATIC BELT CLEANING SYSTEM featuring one man operation is being offered by Sellers Injector Corp., 1600 Hamilton St., Philadelphia 30, Pa. The system operates on plant steam and consists of two basic components; (1) multiple high pressure nozzles spaced at intervals across the width of the belt and positioned permanently under and over the conveyor; and (2) a 400° gph Sellers hydraulic jet unit for supplying the nozzles which is able to combine plant steam, cold water and detergent to deliver hot liquid (180°F) at a discharge pressure 2 to 20 times higher than input steam pressure. The system, according to the manufacturer, is not limited to flat rubber belts but can also be used in cleaning steel mesh belts, metal elevators and elevator belts.



MORE UNIFORM COARSE COAL with fewer fines is produced with the improved style CCMJ Red Bits, according to Vascoloy-Ramet Corp., Waukegan, Ill. Newly designed rake



and clearance angles are given as the reasons. Also, shoulders on the bits reportedly minimize wobble, reduce lug wear and keep fines from packing in the lug.

CATALOGS & BULLETINS

THERMAL DRYER. *The McNally Pittsburg Mfg. Corp., Pittsburg, Kan.*, Bulletin No. 361 covers McNally Pittsburg's newest thermal dryer—the Flowdryer. Brochure gives complete description, photographs and dimensional drawings of the unit.

TROLLEY CONVEYORS. *Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.*, What a trolley conveyor can do to reduce manufacturing and handling costs, and how to select the right trolley conveyor for any requirement—these are the two main topics of "Trolley Conveyors." Book 2730 gives examples of many installations and complete information for design of a trolley conveyor system, with appropriate components, supports, superstructures, and guards. There is also information about Trukveyors, a conveying medium for towing four-wheel platform trucks and dollies, and Link-Belt's power-and-free conveyors which combine powered trolley conveyors and unpowered monorail-type free conveyors that route, store and circulate.

A-C MOTORS. *Reliance Electric and Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio.* Bulletin B-2515 shows and describes the complete line of Reliance Duty Master a-c motors from 1 to 2000 hp. Product features of each motor are clearly outlined and explained for easy selection of the right motor for every application.

LIFT TRUCKS. *Engine-Material Handling Div., Allis-Chalmers, Milwaukee 1, Wis.* Complete with photographs and other illustrations, Catalog BU-660 describes the design, engineering construction and operating features of Allis-Chalmer's line of lift trucks in the 2000 to 10,000-lb capacity ranges and their components and power plants. Also discussed are the power curves, and specifications of each of the trucks along with information on matched attachments available to increase each units' versatility.

CENTRIFUGAL PUMPS. *Goulds Pumps, Inc., 223 Black Brook Rd., Seneca Falls, N.Y.* Complete information on the line of high pressure multi-stage centrifugal pumps manufactured by this company is offered in Bulletin No. 722.4. Described are models 3360–3365 which have capacities up to 2600 gpm for heads up to 3400 ft. Maximum working pressure is 1200 psi. Also included are specifications, performance curves, materials of construction and dimensions.

(Continued on next page)

—ANNOUNCEMENTS—

Centrifugal & Mechanical Industries, Inc., has announced a number of top-level personnel changes. **Elmer O. Binder,** formerly executive vice president, has been elected chairman of the board of directors and president. He has been with the company since 1950 and during this period has worked in a number of executive administrative positions.

P. W. Bigley was elected executive vice president and member of the board of directors. Formerly vice president-sales, he joined the company as sales engineer in 1945, was appointed sales manager in 1948 and vice president in 1959. He is also active in the Committee on Coal Preparation of the American Mining Congress.

E. O. Binder

P. W. Bigley

James E. Bilderback, formerly sales manager, was promoted to vice president-sales and elected a member of the board of directors. He joined the company in 1949 and is also an active member of the American Mining Congress.

CMI also announced that **James C. Artrip** will direct the sales and service activities in the company's Pittsburgh office, and **Lucian C. Morrison** will be in charge of all sales and service activities in the southeastern district, with offices and warehouses located at Huntington, W. Va.

W. S. Tyler Co., Cleveland, has announced the appointment of **Walter J. Parks** as director of product development-Screening Div., and **Edgar E. Gardner** as chief engineer of the Screening Machinery Division. Parks, a veteran of 25 years with Tyler will be responsible for design improvement of existing products as well as development of new products in the screening field. Gardner, who succeeds Parks as chief engineer of Screening Machinery, has been assistant chief engineer of the division.

Leo Stogentin, active for many years in the design, application engineering and sales of slurry, sand, dredge and abrasive material handling pumps has joined the Pump Division of **Pettibone Mulliken Corporation,** Chicago.

Myron Geller has been named sales manager of the Wheel Excavator Division of the **Wellman Engineering Co.,** Cleveland. He will be responsible for promotion and sales of the Demag-Lauchhammer line of wheel excavators, reclaimers, stackers, and barge wheel unloaders in the United States and Canada. From 1949 to 1954 Geller was a sales representative for Bucyrus-Erie Co., and was employed by Marion Power Shovel Co. from 1955 to 1961, becoming sales manager in 1958.

Two new appointments have been made in the Engineering and Construction Department of **Dravo Corp's** Machinery Division in order to effect closer coordination between sales and development engineering work in the department's ore processing activities. Appointed manager-sales and development was **Philip J. Berg** and chief development engineer-ore processing, **J. H. Porteus,** who will report to Berg.

Link-Belt Co. has made announcements concerning two personnel developments. **Robert A. Gordon** has been named assistant manager of district sales, with headquarters at the Chicago executive offices, and will assist in coordinating all phases of district office operations.

Robert W. Miller has been appointed assistant sales manager at the Pershing Road plant in Chicago succeeding **Albert W. Holmes** who has retired after 38 years service with Link-Belt.

(continued from previous page)

RAILWAY AND INDUSTRIAL EQUIPMENT. *The Nolan Co., Bowerston, Ohio.* Profusely illustrated with the latest product developments for the mining and industrial fields, Catalog No. 10 covers such equipment as all-steel push cars, tool and supply car, track dolly carry-cart, rail dolly, and bumping posts, in addition to the standard Nolan line of rerailers, derailers, car door openers, and other railroad and industrial items.

METERS. *Technical Information Dept., Beckman Scientific and Process Instruments Div., Fullerton, Calif.* A new descriptive bulletin, 719-B, reports features, applications and specifications of Beckman Model G and GS pH meters. Model G is used for research analyses, routine pH and millivolt determinations, and quality control applications. Model GS, a modification of Model G, employs two additional controls to provide 20 times greater meter sensitivity and an eight-fold increase in readability.

DEWATERING PUMPS. *Advertising Dept., The Gorman-Rupp Co., 305 Bowman St., Mansfield, Ohio.* Form 1-VS-11 describes Gorman-Rupp's three-in. electric motor driven Submersible Dewatering Pump, Model 3V51, and contains in addition to general information, specifications, performance, a cross-section drawing ,and application and product pictures.

ELECTRICAL EQUIPMENT FOR CEMENT INDUSTRY. *Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.* How improved electrical systems can make cement plants more profitable is discussed in Booklet B-7891, which covers the company's services and products for the cement industry. Illustrated with photographs and drawings, the booklet includes sections on electrical distribution apparatus, control centers, motors and drives, maintenance services and research presently being conducted to improve these services.

DIESEL ENGINES FOR SHOVELS AND DRAGLINES. *White Diesel Engine Div., The White Motor Co., Springfield, Ohio.* Superior Model 40 diesel engines are four-cycle units available in four models—six or eight cylinders, naturally aspirated or supercharged. Bulletin No. 125 covers construction features of these engines and their applications in shovels and draglines. They are rated from 385 to 800 bhp continuous for O.E.M. or repowering service.

SPECIALIZED BUCKETS. *Page Engineering Co., Clearing Post Office, Chicago, 38, Ill.* Brochure describes Page Automatics in the 4 to 7 cu yd range. The series is being offered in two groups: General purpose for general contracting operations where a variety of types of material are encountered; and Heavy Duty for digging in rugged material such as hardpan, blasted rock and shale.

HOSE ASSEMBLIES. *Advertising Dept., Aeroquip Corp., Jackson, Mich.* To be used as a guide to Aeroquip hose assembly numbers, Bulletin IEB-53 covers the various categories of end fittings used for low, medium and high pressure hose assemblies in addition to hose assemblies of Teflon with "super gem" Fittings. Bulletin also provides hose types to be used with each type of fitting.

A-C BRAKE. *General Electric Co., Schenectady 5, N. Y.* Use of Thrustor and solenoid-operated spring-set two-shoe brakes are discussed in Bulletin GEA-1518D including description of adjustable braking torque, smooth braking action, low maintenance and time delay for floor or motor mounting on either a-c or d-c motors. There are also lists of optional hand releases, limit switches, and enclosures that are available.

DRY TYPE TRANSFORMERS. *Atlantic Transformer, 8330 Hegerman St., Philadelphia 36, Pa.* Complete with photographs, wiring diagrams, specifications and prices, the company's 36 page catalog describes its extensive line of single phase, three phase and phase changer dry type transformers.

PARTS ASSEMBLY EXCHANGE PROGRAM. *Advertising Div., Caterpillar Tractor Co., Peoria, Ill.* The program is completely explained in a booklet entitled "Avoid Delay the Modern Way" (Form D115), which includes stories from owners, mechanics and job superintendents on how exchange assemblies have helped them cut down time and save money. Under the program, a machine owner orders a needed replacement assembly from his dealer. The dealer delivers the rebuilt component, taking the customer's unit into the shop to be put in working condition. The owner is then billed for repair costs on his old unit, which are about the same as if he had repaired the assembly himself. Sold as "Bonded Buy" units, exchange assemblies are guaranteed in writing and backed by a $5000 bond.

AUTOMATIC DUST COLLECTOR. *Automatic Collector Div., Torit Mfg. Co., 1131 Rankin St., St. Paul 16, Minn.* Eleven models of the Torit Automatic dust collector are made possible by its modular design, and this folder describes their dimensions and filter areas, operation, and self-cleaning mechanism.

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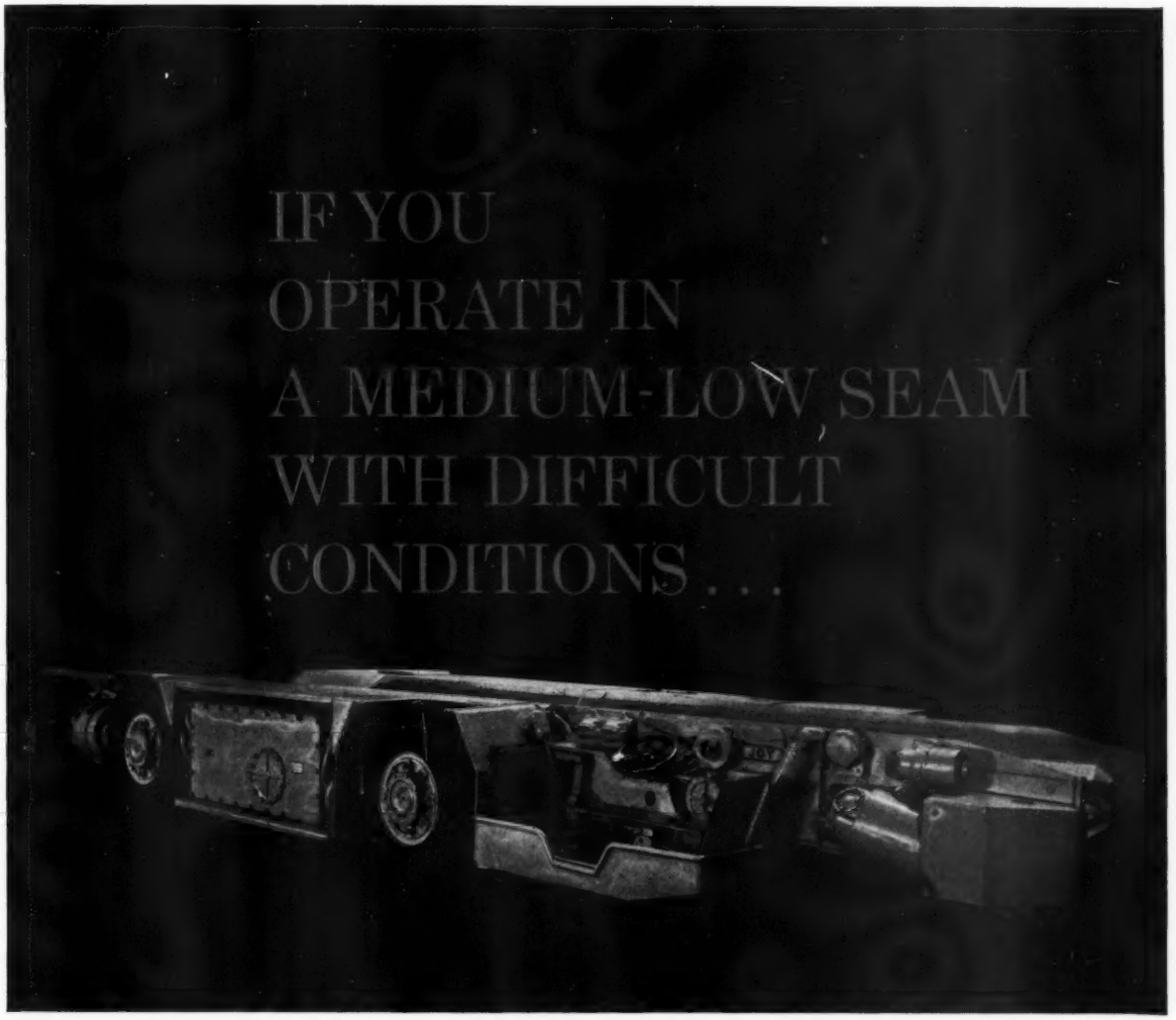


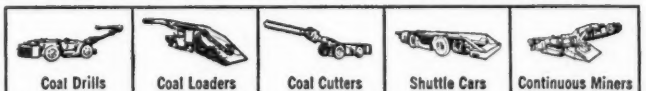
Joy 16-SC four-wheel shuttle car

Under the most difficult working conditions of heavy loads, uneven grades and bad bottom, the 4-wheel 16-SC stays in top working order. It's deliberately built to take a pounding with wheel units that are 53% stronger than ever before.

The two standard DC traction motors are 7½ hp each. For unusually steep grades or heavy loads, larger motors may be supplied. Optional motors for DC cars are 10 hp series-wound; on AC cars, they are 20/20 hp. All motors and working parts are easy to reach for inspection and maintenance.

The 16-SC's basic height is 33 inches. With four inch sideboards it will handle 155 cu. ft. of coal. Two other models, one just 30½" high, have the same extra-rugged construction. Conveyor widths are available to 56". Ask your Joy engineer about applying the proper 16-SC to your most difficult haulage problems. He has complete information.

WORLD'S LARGEST MANUFACTURER OF UNDERGROUND MINING MACHINERY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

New M-S-A® Pager gives you the convenience and flexibility of a telephone with the amplification of a loud speaker

Now, with one versatile communications unit, you can page key personnel over a loud speaker or converse semi-privately by phone. A flip of the switch on the new M-S-A Pager lets you do either.

Uses Existing Lines

The new unit is a completely self-contained, transistorized telephone. Individually battery-powered, these units utilize existing phone lines, and can be used in conjunction with most other telephones.

Simultaneous Paging

Ten or more Pagers can be installed on a single line. This makes it quite simple to page key men from a number of points . . . simultaneously. Once the man answers, a flip of the switch converts the Pager into a regular telephone for private or semi-private conversing.

24 Volts for Paging . . . 12 Volts for Talking

Two dry cell batteries provide the power source. And the power is expended only when the unit is in use, thus conserving battery life. Estimated battery life: 2 to 3 months on a 5% duty cycle.

Easy Installation and Maintenance

Weighing about 25 pounds, the M-S-A Pager can be mounted on a timber or a rib. All parts readily accessible with removal of four fastening screws which open the front half of the case. Transistors are vibration-proof . . . no filaments . . . so high efficiency, long life are assured.

For additional information, ask the MSA representative to call. And write us for helpful new product data bulletin.

Mine Safety Appliances Company, Pittsburgh 8, Pa. In Canada: Mine Safety Appliances Co. of Canada, Ltd., 500 MacPherson Avenue, Toronto 4, Ontario.

MSA

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